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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : B32B 5/26, 7/04, D04H 13/00, 1/54, A61F 13/15

A1

(11) International Publication Number: WO 96/11107

(43) International Publication Date: 18 April 1996 (18.04.96)

(21) International Application Number: PCT/US95/11586

(22) International Filing Date: 13 September 1995 (13.09.95)

(30) Priority Data:
08/330,150 6 October 1994 (06.10.94) US

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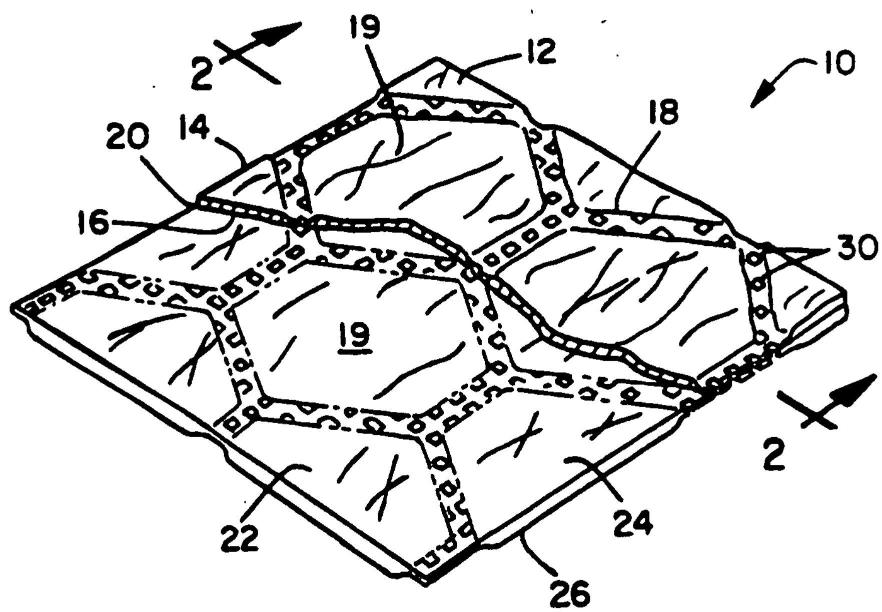
(81) Designated States: AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LT, LU, LV, MD, MG, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TT, UA, UG, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG), ARIPO patent (KE, MW, SD, SZ, UG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: FIBROUS WEBS AND METHOD AND APPARATUS FOR MAKING THE SAME AND ABSORBENT ARTICLES INCORPORATING THE SAME

(57) Abstract

This invention relates fibrous materials, including fibrous laminated materials wherein a first fibrous layer (12) comprising a plurality of staple fibers or continuous filaments of a thermoplastic material and a second fibrous layer (22) comprising a plurality of staple fibers or continuous filaments of two or more thermoplastic or other materials are bonded together in a spaced apart bonding pattern (18) having apertures (30) formed therein to form a fibrous laminate having improved liquid distribution and management porperties as well as enhanced comfort and softness when placed in contact with human skin. In another aspect of this invention, a fibrous material is disclosed wherein a single fibrous layer comprising a plurality of staple fibers or continuous filaments of one or more thermoplastic materials is bonded in a spaced apart bonding pattern having apertures formed therein to form a fibrous web having improved liquid distribution and management properties and air circulation and permeability properties. Also disclosed are methods and apparatus for making such fibrous materials, as well as absorbent articles incorporating such fibrous materials.



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FIBROUS WEBS AND METHOD AND APPARATUS FOR MAKING THE SAME AND ABSORBENT ARTICLES INCORPORATING THE SAME

RELATED APPLICATIONS

This application is a continuation-in-part of co-pending International Application PCT/US93/10749 filed on November 8, 1993, and which designated the United States. International Application PCT/US93/10749 designating the United States was a continuation-in-part of co-pending U.S. Ser. No. 07/973,146 filed on November 6, 1992. This application is further related to co-pending U.S. Ser. No. 07/973,145 filed on November 6, 1992.

BACKGROUND OF THE INVENTION

This invention generally relates to fibrous webs and fibrous web laminates suitable for use in articles used to absorb, distribute and retain body liquids, such as disposable diapers, sanitary napkins, incontinence garments and the like, and to a method and apparatus for making same. More specifically, this invention relates to nonwoven materials, including nonwoven laminated materials, having improved liquid distribution and management and air circulation properties as well as enhanced comfort and softness when placed in contact with human skin, and to nonwoven materials and nonwoven laminated materials having improved liquid penetration and management properties when placed within the internal structure of an absorbent article.

Nonwoven materials, such as spunbonded webs and carded webs, have been used as bodyside liners in disposable absorbent articles. Typically, very open, porous liner structures have been employed to allow liquid to pass through them rapidly, thereby keeping the wearer's skin separate from the wetted absorbent core underneath the liner. Also, other layers of material, such as those constructed with thick, lofty fabric structures, have been interposed between the liner and

absorbent pad for the purpose of reducing flowback.

U.S. Patent No. 4,761,322 to Raley discloses a fibrous web laminate wherein a fibrous layer having a soft texture is laminated with a contiguous layer having a greater structural integrity such that the soft texture layer may be utilized as a skin-contacting surface and the contiguous layer thereto may provide mechanical strength and integrity to the laminate. The laminate of this patent includes a first fibrous layer, which is pattern bonded in a first spaced-apart bonding pattern, formed, for example, by passing the first layer through the nip formed by a first heated pattern roll and a smooth roll, and a second fibrous layer, which is pattern bonded in a second spaced-apart bonding pattern, formed, for example, by passing the first and second layers through the nip formed by a second heated pattern roll and a smooth roll. The second bonding pattern further produces bonds between the first and second layers, while the first bonding pattern does not.

U.S. Patent No. 4,392,862 to Marsan et al. discloses an absorptive device including a facing element, a support element, an absorbent core and a backsheet. The facing element is a fluid permeable, unbonded, carded web of hydrophobic, thermoplastic fibers. The facing element is bonded in spaced apart bonding regions to a fluid permeable support element of nonwoven polyester or monofilament scrim.

U.S. Patent No. 4,088,726 to Cumbers discloses a method of making nonwoven fabrics wherein a nonwoven web of thermally bondable material is passed through a nip between co-operating calender rolls, at least one of which is heated, with one calender roll having a surface pattern consisting of continuous lands and the other calender roll having a surface pattern consisting of lands that are isolated projections and the centroids of area of those projections concurrently in the nip being disposed at differing distances from the longitudinal axis of the nearest continuous land surface so that lands that oppose each other in the nip overlap to different extents.

Notwithstanding the development of nonwoven materials of the types described above, the need remains for a nonwoven material that can provide improved liquid intake and distribution as well as air circulation when used as a body contacting layer in a disposable absorbent article, resulting in greater surface dryness and comfort for the wearer's skin. There also is a need for a nonwoven material that exhibits improved softness and comfort when placed in contact with the wearer's skin. In addition, the need exists for a nonwoven material that exhibits improved liquid penetration and management properties when placed within the internal structure of an absorbent article.

SUMMARY OF THE INVENTION

This invention relates to nonwoven materials, including a nonwoven laminated material wherein a first nonwoven layer comprising a plurality of staple fibers or continuous filaments of a thermoplastic material and a second nonwoven layer comprising a plurality of staple fibers or continuous filaments of two or more thermoplastic materials are bonded together in a spaced apart bonding pattern having apertures formed therein to form a nonwoven laminate having improved liquid distribution and management properties as well as enhanced comfort and softness when placed in contact with human skin. Also disclosed are a method and apparatus for making such a nonwoven laminate, as well as absorbent articles incorporating such nonwoven laminate.

In another aspect of this invention, a nonwoven material is provided wherein a single nonwoven layer comprising a plurality of staple fibers or continuous filaments of one or more thermoplastic materials is bonded in a spaced apart bonding pattern having apertures formed therein to form a nonwoven web having improved liquid distribution and management properties as well as air circulation and permeability properties. Also disclosed are a method and apparatus for making such nonwoven material and absorbent articles incorporating the same.

BRIEF DESCRIPTION OF THE DRAWINGS

The nonwoven material of this invention will be better understood by reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings.

FIG. 1 is a perspective partial sectional view of a nonwoven laminated material according to the present invention;

FIG. 2 is a cross-sectional elevational view of the nonwoven laminated material of FIG. 1 taken along line A-A of FIG. 1;

FIG. 3 is a schematic diagram showing process apparatus for forming a nonwoven laminated material in accordance with the present invention;

FIG. 3a is a perspective view of thermal bonding rolls for forming a nonwoven laminated material in accordance with the present invention;

FIGS. 3b and 3c are enlarged views of portions of the outer surfaces of the thermal bonding rolls of FIG. 3a;

FIG. 4 is a cross-sectional view through a disposable diaper including the nonwoven laminated material of the present invention positioned on the side of the diaper that will be placed next to the infant's body;

FIG. 5 is a photomicrograph (13.2 magnification, 12 mm working distance, 5 KV accelerating voltage) of a portion of the apertured bonding region of the nonwoven laminated material of the present invention, with the first layer of the nonwoven laminated material facing the viewer;

FIG. 6 is a photomicrograph (28.7 magnification, 12 mm working distance, 5 KV accelerating voltage) of a portion of the apertured bonding region of the nonwoven laminated material of the present invention, with the second layer of the nonwoven laminated material facing the viewer;

FIG. 7 is a perspective view of a testing apparatus used to evaluate fluid intake and flowback of nonwoven laminated materials of the type described herein;

FIG. 8 is a cross-sectional view of FIG. 7;

FIG. 9 is a perspective view showing a fluid flowback

testing apparatus used to evaluate nonwoven laminated materials of the type described herein;

FIG. 10 is a cross-sectional view of FIG. 9;

FIG. 11a is a partially cut away, top plan view of a disposable diaper including the nonwoven laminated material of the present invention positioned adjacent the inner surface of the bodyside liner between the attached edges of a pair of containment flaps;

FIG. 11b is a cross-sectional view through the disposable diaper of FIG. 11a, wherein the elastic members at the distal edges of the containment flaps have urged sections of the flaps to a generally upright position, spaced away from the bodyside liner;

FIG. 11c is a perspective view of the disposable diaper of FIG. 11a, wherein the leg elastics and flaps elastics have contracted and gathered the side margins of the diaper and the distal edges of the containment flaps;

FIG. 12 is a perspective view of a single layer nonwoven material according to the present invention;

FIG. 13 is a cross-sectional elevational view of the nonwoven material of FIG. 12 taken along line 13-13 of FIG. 12.

DETAILED DESCRIPTION

The present invention generally comprehends a fibrous fabric or material, including a laminated fabric or material, that is bonded in a spaced apart bonding pattern with apertures formed within certain bonding regions of said bonding pattern.

In a specific embodiment of the present invention, a fibrous laminate formed in accordance with this invention includes a first fibrous layer comprising a plurality of staple fibers or continuous filaments of one or more thermoplastic materials and a second fibrous layer comprising a plurality of staple fibers or continuous filaments of two or more thermoplastic materials. The first layer and second layer, which can be nonwoven webs, are formed into a fibrous laminate by a spaced apart bonding pattern, such as by thermal bonding between a

pair of heated embossing or bonding rolls having raised bonding patterns on the outer surfaces thereof. This spaced apart bonding pattern provides high structural integrity between the first and second layers without compromising the flexibility and soft surface texture of the first layer or the loftiness of the resulting fibrous laminate. Apertures are formed in the spaced apart bonding areas to enhance liquid distribution and air circulation through the respective layers of the fibrous laminate.

The fibrous material or laminate formed in accordance with the present invention exhibits improved liquid intake and distribution and air circulation characteristics, resulting in greater surface dryness and comfort when placed against human skin. The fibrous material or laminate of this invention further provides a lofty, pillowed structure that exhibits improved softness and cushiony feel to the user. The fibrous material or laminate of this invention also provides improved liquid penetration and management when placed within the internal structure of an absorbent article. Other attributes and advantages of the present invention will be apparent from the ensuing disclosure and appended claims.

As used herein, the terms "nonwoven web" and "nonwoven layer" mean a fibrous web or layer having a structure of individual fibers or filaments that are interlaid in a random pattern. Nonwoven webs have been formed in the past, as known to those of ordinary skill in the art, by a variety of processes, such as, for example, meltblowing, spunbonding, air-laying, wet-laying, dry-laying, dry staple and carded web processes. While nonwoven webs can be used in practicing the present invention, the invention is not to be considered limited to nonwoven materials and other suitable fibrous structures may be employed.

The fibrous material of this invention will be described herein in connection with its use in disposable absorbent articles, however, it should be understood that potential applications of this invention need not be limited to such disposable absorbent articles. As used herein, the term

"disposable absorbent article" means an article that is used to absorb and retain body exudates and is intended to be discarded after a limited period of use. Such articles can be placed against or in close proximity to the body of the wearer to absorb and retain various exudates discharged from the body.

Referring now to FIG. 1, a perspective partial sectional view of an embodiment of the present invention is shown. The nonwoven material 10 comprises a first nonwoven layer 12 and a second nonwoven layer 22. The first layer 12 has an upper surface 14 and a lower surface 16 and the second layer 22 has an upper surface 24 and a lower surface 26. In the embodiment shown, a plurality of thermal fusion bonds in a spaced apart bonding pattern 18 extend through the thickness of the nonwoven material 10 to thermally fuse or bond fibers of first layer 12 with fibers of second layer 22 at the interface 20 therebetween. Bonding of the first and second layers is substantially limited to the bonding regions 18. That is, in the areas 19 of the first and second layers outside of the bonding pattern 18, the fibers of the respective layers are only lightly bonded to one another by fiber fusing from thermal energy. Thus, the bonding regions 18 are separated or "spaced apart" by lightly bonded areas 19. Also as shown in this embodiment, apertures 30 are formed within the bonding areas 18 to improve the liquid distribution rate and air circulation of the nonwoven material 10.

The respective first and second fibrous layers of the present invention may be formed by any suitable natural or synthetic fibers in any appropriate structure, although in the embodiments shown in the accompanying drawings, these fibers are formed into nonwoven layers. In general, each nonwoven layer of the present invention can be prepared from noncontinuous fibers, continuous filaments or a combination thereof. The method of producing each layer in the embodiment shown employs dry staple processes, or more specifically, carded web techniques, as known to those of ordinary skill in the art. While carded web techniques can be advantageously

employed in forming the respective layers of the present invention, spunbonding, meltblowing, air-laying and other techniques known to those of ordinary skill in the art that produce noncontinuous fibers and continuous filaments are also considered within the scope of this invention. Carded webs suitable for use in the practice of the present invention can have the fibers in an aligned or an unaligned configuration. Conventional carding machines, as known to those of ordinary skill in the art, can be employed in producing the respective layers of the present invention.

Commercially available thermoplastic polymeric materials can be advantageously employed in both layers of the present invention. Examples of such polymers, by way of illustration only, include polyolefins, polyamides, polyesters and the like. The fibers may have any suitable morphology and may include hollow or core fibers, shaped fibers, bicomponent fibers or high absorbent particle impregnated fibers.

In the embodiment shown in FIG. 1, the first nonwoven layer 12 of the nonwoven fabric 10 is a bonded carded web made of thermoplastic polypropylene fibers. The second nonwoven layer 22 of the nonwoven fabric is a substantially unbonded or unbonded carded web made of a blend of polypropylene and polyester fibers. By "substantially unbonded" as used herein is meant a web with fibers that are sufficiently bonded together, by known bonding processes, for handling the web, but insufficiently bonded to provide the needed strength and integrity for the end-use application. By "unbonded" as used herein is meant a web with fibers that are not mechanically, thermally nor chemically bonded together.

The ratio of different thermoplastic fibers in the second layer 22 can be varied as appropriate for the intended end-use application of the nonwoven material. For example, the ratio of polypropylene to polyester fibers by total weight of the second layer 22 can range from about 70:30 to about 25:75, with about 40:60 being the ratio for the embodiment shown.

It is an important advantage of the present invention that certain materials that might not have optimum properties in

a nonwoven web for various reasons may be used in the present invention in combination with a web made from one or more different materials to produce a better set of properties. For example, an unbonded or substantially unbonded nonwoven layer of polypropylene and polyester fibers may be considered too soft and weak for certain nonwoven web applications. However, in following the teachings of the present invention, a nonwoven layer made of an appropriate blend of polypropylene and polyester fibers can be bonded to a stronger nonwoven web, such as a bonded layer of polypropylene fibers, to thereby make a more desirable nonwoven laminate.

The fiber sizes, basis weights and densities of the fibrous layers comprising the nonwoven fabric 10 of the present invention also can be readily varied depending on the intended use of the web. For example, in one application of the present invention, the nonwoven material can be used as a body facing layer for a disposable absorbent article having an absorbent core placed between the liner and an outer cover. Such disposable articles include, by way of illustration only, diapers, training pants, sanitary napkins, incontinence garments and the like. For this application, the polypropylene fibers of the first layer 12 can be as fine as about 1.0 denier (12.5 μm in diameter) to as coarse as about 3.0 denier (21.6 μm) and have a crimped fiber length of from about 1.25 in. (31.75 mm) to about 2.5 in. (63.5 mm), although it is desireable for the user's comfort that the fibers be from about 2 denier (17.6 μm) to about 2.2 denier (18.5 μm) and have a crimped fiber length of about 1.5 in (38.1 mm). (It is known in the art that crimping is a function of fiber type, diameter and density.) The finer fiber size of the polypropylene fibers in the first layer 12, which in this application comes into contact with human skin and functions as a liner layer, yields a softer surface texture for the first layer 12. The polypropylene fibers in the second layer 22 can, but need not, be identical to the polypropylene fibers in the first layer 12. The polyester fibers in the second layer can be from about 3 denier (17.5 μm) to about 9 denier

(30.4 μm) and have a crimped fiber length of from about 1.25 in. (31.75 mm) to about 3 in. (76.2 mm), with polyester fibers of 6 denier (24.8 μm) having a crimped fiber length of about 2 in. (50.8 mm) being suitable. While not wishing to be bound by any particular theory, it is currently believed that the use of different fibers enhances the liquid wicking and distribution properties of the second layer 22. The fibers in the first layer 12, which have the same diameters, tend to form similarly sized pores in a single plane, while the fibers in the second layer 22, which have different diameters, tend to form pores of varying sizes in multiple planes. The differing pore sizes in multiple planes in second layer 22 are believed to enhance wicking of liquid throughout the second layer 22 and liquid intake into and distribution through the second layer 22. It is further currently believed that the resiliency of the polyester fibers is a contributing factor to the improved liquid management and air circulation characteristics of the nonwoven laminate of this invention. Consequently, in this application, the second layer 22 functions as a surge layer or temporary reservoir for the liquid passing through the nonwoven material 10 into the absorbent core of an absorbent article.

The nonwoven material 10 of this invention can have a basis weight from about 25 g/m^2 (.7 oz/yd^2) to about 78 g/m^2 (2.3 oz./yd^2), a thickness of from about 0.03 in. (0.76 mm) to about 0.08 in. (2.03 mm) and a density of from about 0.020 g/cc to about 0.050 g/cc. Density is determined using the following equation:

$$\frac{\text{Basis Weight (g/m}^2\text{) x 0.0000394}}{\text{Thickness (in.)}} = \text{Density (g/cc)}$$

For example, in the embodiment shown, the basis weight for the nonwoven web 10 can range from about 47 g/m^2 (1.4 oz/yd^2) to about 58 g/m^2 (1.7 oz/yd^2), the thickness can range from about 0.04 in. (1.02 mm) to about 0.06 in. (1.52 mm) and the density can range from about 0.030 g/cc to about 0.045 g/cc.

The basis weight of the nonwoven material 10 was measured

using a device that measures the weight of a sample of the nonwoven material. Each sample measured no less than 4 in^2 (2580 mm^2). Each sample was cut, smoothed to eliminate folds or wrinkles, and weighed on an analytical balance to the nearest 0.01 g. The basis weight then was calculated by dividing the sample weight by the sample area.

The thickness of the nonwoven material 10 was measured using a device that applies a constant loading pressure of 0.05 psi (35.15 kg/m^2) to a sample of the nonwoven material. Each sample measured at least 5 x 5 in. (127 x 127 mm). Each sample was cut out, smoothed to eliminate folds or wrinkles, placed under a circular plexiglass platen (foot) having a 3 in. (76.2 mm.) diameter, centered as much as possible, and the platen then was lowered onto the specimen. The thickness of each sample was recorded to the nearest 0.001 in. (0.0254 mm).

Although in alternative embodiments, the basis weight and density of the first layer 12 prior to bonding to the second layer 22 can vary in relation to that of the second layer 22, the embodiment shown includes a first layer 12 having a lower basis weight and a higher density than the second layer 22. The basis weight for the first layer can range from about 0.4 oz/yd^2 (16 g/m^2) to about 0.8 oz/yd^2 (28 g/m^2), with about 0.5 oz/yd^2 (18 g/m^2) to about 0.6 oz/yd^2 (22 g/m^2) being desireable, and the basis weight for the second layer can range from about 0.7 oz/yd^2 (24 g/m^2) to about 1.02 oz/yd^2 (35 g/m^2), with about 0.9 oz/yd^2 (32 g/m^2) being desireable. The density for the first layer can range from about 0.050 g/cc to about 0.065 g/cc, with about 0.055 g/cc being desireable, and the density for the second layer can range from about 0.024 g/cc to about 0.045 g/cc, with about 0.035 g/cc being desireable.

Referring now to FIG. 2, a cross-sectional view of the embodiment of the nonwoven material 10 of the present invention described above is shown, comprising a first nonwoven layer 12 and a second nonwoven layer 22. A series of bonds forming a spaced apart bonding pattern 18 extend

through the thicknesses of the respective layers and bond the first layer 12 to the second layer 22 at the interface 20 in the bonding regions 18. The manner of forming the spaced apart bonding pattern 18 now will be described.

The spaced apart bonding regions 18 may be produced by any suitable method of bonding the respective first and second layers to one another at the interface 20 therebetween that yields a nonwoven material 10 having the liquid management, air circulation and other properties described herein. Thermal bonding, which includes the use of a pair of heated embossing rolls, is considered a useful method of forming the bonding pattern 18, as described in greater detail hereinbelow.

The present invention contemplates bonding of the respective layers in various sequences. For example, the first layer 12 may be formed and bonded in a first operation, with the second layer 22 formed in a second operation and then bonded to the first layer 12 in yet a further operation. Alternatively, the first layer 12 may be formed in a first operation, the second layer 22 formed in a second operation, and the respective layers bonded together in still another separate operation which simultaneously bonds the fibers in the first layer 12 to one another. The thermoplastic fibers of second layer 22, which are initially unbonded or substantially unbonded, do have a degree of thermal bonding when formed into the nonwoven laminated material 10, as further described below.

In the embodiment shown, the fibers of the first layer 12 have a greater extent of bonding relative to the fibers of the second layer 22. For example, first layer 12 may be thermobonded by passing the layer 12 between a pair of bonding rolls of conventional construction (i.e., an engraving roll and a smooth roll) heated to a temperature of between 270°F (132°C) and 300°F (149°C), with 275°F (135°C) to 285°F (141°C) being desireable. The appropriate temperature for bonding layer 12 using thermal bonding rolls will vary depending upon the rotational surface speeds and diameters of the bonding rolls and the thermoplastic fibers used. The first layer 12

may alternatively be bonded by other known bonding processes, such as by pattern adhesive bonding, needling or hydro or airjet entangling of the fibers. In this embodiment, the first layer 12 has a higher density than the second layer 22. In this way, the first layer 12, which has greater structural integrity and mechanical strength than the second layer 22, can provide a base substrate for the second layer 22.

The degree of bonding of the first layer 12 to the second layer 22 may be controlled in the spaced apart bonding region 18 by altering the percent bond area, which refers to the surface area of the interface between the respective layers that is occupied by bonds within the bonding regions. Thus, as shown in FIGS. 1 and 2, the interface 20 of the first layer 12 and second layer 22 has a spaced apart pattern of bonds 18 disposed across its surface and the ratio of the surface area occupied by the bonding regions 18 to the total area of the surface of the interface 20 is the percent bond area for the interface 20. In the embodiment shown, the percent bond area of the nonwoven laminate can range from about 1% to about 6%, with about 2% to about 4% being desireable. While a hexagonal (honeycomb-like) bonding pattern is shown in this embodiment, the present invention encompasses other geometric, non-geometric, repeating and non-repeating bonding patterns, which are suitable for incorporation into the nonwoven material of the present invention.

FIG. 3 is a schematic diagram of the apparatus used for forming the above-described embodiment of the nonwoven laminated material of the present invention. As stated above, conventional carding machines, such as described in U.S. Patent Nos. 3,604,062 and 3,604,475, can be employed in producing the respective layers of the present invention. As shown, the first carding machine 42 lays down the first layer 12 on a moving belt 40, while the second carding machine 52 lays down the second layer 22 on top of the first layer 12. In this way, first layer 12 acts as a base substrate for second layer 22 as the two layers pass through the forming process.

Optionally, the two layers may be passed through a pair of compacting rollers that slightly compact the fibrous webs to thereby increase the integrity of the webs and to aid in further processing. One or both of the layers also may be passed through apparatus that orients the fibers in the web to optimize material strength in the machine direction (MD) and cross direction (CD). As used herein, machine direction (MD) refers to the direction in which the web was laid down (from left to right in FIG. 3) and cross direction (CD) refers to the axis perpendicular to the direction in which the web was laid down. MD strength for the nonwoven laminate of this invention must be sufficiently high (at least about 900 g/in. (354 g/cm) to about 2700 g/in. (1062 g/cm), with at least about 1300 g/in. (512 g/cm) being desireable) so that the nonwoven webs will not be broken during high speed manufacturing processes used for producing disposable absorbent articles, such as diapers.

The two nonwoven layers next pass through the two bonding rolls 60 and 70. In the embodiment shown in FIGS. 3 and 3a, both bonding rolls are heated and have raised (male) bonding patterns on the outer surfaces thereof. The lower roll 60 has a spaced apart bonding pattern 62 on its surface, while the upper roll 70 has raised bonding points 72 on its surface. In alternative embodiments, the positions of the bonding rolls can be reversed. It is a feature of this invention, therefore, that thermal bonding rolls having different male or raised bonding patterns on each of the outer surfaces thereof are employed to create a spaced apart bonding pattern for bonding together the respective layers of the nonwoven material.

As the two nonwoven layers 12 and 22 pass between these two heated rolls 60 and 70, each layer becomes stabilized by the formation of discrete compacted bonding areas 18 of thermally induced fiber bonds that extend through a major portion of the thickness of each nonwoven layer. The thickness of the compacted or bonded regions 18, which may vary depending upon the thicknesses of the respective layers 12 and 22, can range

from about 50 μm to about 150 μm, with about 70 μm to about 110 μm being used in the embodiment shown herein. The compacted bonded areas of nonwoven material 10 are distributed in a bonding pattern 18 formed by the points of contact between the raised bonding patterns on the two heated rolls 60 and 70, with lightly bonded fiber spans 19 therebetween.

Apertures 30 are formed in the bonded areas 18 formed by the points of contact between the raised patterns on the heated bonding rolls 60 and 70, as described in greater detail below. While the exact size and shape of the apertures 30 are not considered critical by the inventor (see FIGS. 5 and 6), apertures having average diameters ranging from about 8 μm to about 580 μm or more can be advantageously employed in the present invention, with aperture average diameters from about 29 μm to about 277 μm being desireable. As shown in FIGS. 5 and 6, the apertures 30 are substantially free of fibers throughout the thickness of the nonwoven laminated material 10 and provide a non-tortuous pathway for liquid to pass through the nonwoven material 10. The apertures 30, consequently, allow rapid liquid intake through the first layer 12 into the second layer 22 and finally into the absorbent core of an absorbent article. It has been observed that liquid primarily flows away from the point of contact with the nonwoven material 10 along the apertured bonding regions 18, which act as channels for the liquid. The apertures 30 are to be distinguished from the pores formed between fibers in layers 12 and 22, which are not sufficiently large nor non-tortuous to allow such rapid liquid intake and distribution. Consequently, a nonwoven fabric 10 is shown having spaced apart bonded areas 18 with lightly bonded areas 19 therebetween and apertures 30 formed in the bonded areas 18.

Two parameters of concern in regard to the specific combination of raised patterns on the bonding rolls that are used are the size of the raised bonding areas of the bonding rolls and the distance or spacing separating the bonding areas. These two parameters together affect the percentage

of area on the nonwoven material 10 that becomes bonded, as described above. It is important that the percent bond area be great enough to insure sufficient integrity of the web for its intended use. On the other hand, it is important that the percent bond area not be too great, as a higher percent bond area usually produces a web with reduced softness. The percent bond area of the lower roll 60 (the ratio of the surface area of the raised bonding pattern 62 to the total area of the outer surface of lower roll 60) of this embodiment can range from about 9% to about 20%, with about 18% to about 19.5% being desireable. The percent bond area of the upper roll 70 (the ratio of the surface area of the raised bonding points 72 to the total area of the outer surface of lower roll 70) of this embodiment can range from about 10% to about 30%, with about 11% to about 20% being desireable. As noted above, the percent bond area of the nonwoven laminate 10, which is the mathematical product of the percent bond areas of the upper roll 70 and lower roll 60, can range from about 1% to about 6%, with about 2% to about 4% being desireable.

It is further important that the raised bonding patterns of the two bonding rolls be combined to optimize the number of apertures within the bonded areas. In the embodiment shown in FIGS. 3a, 3b and 3c, the width of the raised bonding pattern 62 on the outer surface 64 of the lower roll 60 can range from about 0.04 in. (1.0 mm) to about 0.08 in. (2.0 mm), with a width of about 0.07 in. (1.8 mm) being desireable, and the width at the base 66 of the raised bonding pattern 62 can range from about 0.06 in. (1.6 mm) to about 0.12 in. (3.1 mm), with about 0.11 in. (2.8 mm) being desireable. The raised bonding pattern 62 of the lower roll 60 in this embodiment has an engraving depth of about 0.04 in. (1.0 mm), which is the distance between the outer surface 64 and base 66 of the raised bonding pattern 62. The individual hexagons 68 of the raised bonding pattern 62 of lower roll 60 can have a repeating width W of from about 0.65 in. (16.50 mm) to about 0.68 in. (17.33 mm), a repeating height H of from about 1.10

in. (28 mm) to about 1.18 in. (30 mm), and a pitch P of about 0.65 in. (16.50 mm) to about 0.68 in. (17.33 mm) at a pitch angle of from about 45° to about 60°.

Still referring to FIGS. 3a, 3b and 3c, the width of the raised bonding points 72 on the outer surface 74 of the upper roll 70 can range from about 0.028 in. (0.70 mm) to about 0.031 in. (0.80 mm), with a width of about 0.030 (0.75 mm) being suitable. As is conventional in the art, the width at the base 76 of the raised bonding points 72 is slightly greater than the width on the outer surface 74. The raised bonding points 72 of the upper roll 70 can have an engraving depth of about 0.026 in. (0.65 mm). The individual raised bonding points 72 in this embodiment are arranged at about 218.0 bonding points/in^2 (33.8 bonding points/cm^2) and have a repeating width W′ of about 0.094 in. (2.4 mm) to about 0.118 in. (3.0 mm), a repeating height H′ of about 0.068 in. (1.72 mm), and a pitch P′ of about 0.068 in. (1.72 mm) at a pitch angle of from about 30° to about 45°. While in the embodiment shown, the outer surface 74 of the raised bonding points 72 is in the form of a square, other geometric and non-geometric shapes may be employed as the raised bonding points 72 of upper roll 70.

The inventor has observed in optimizing the nonwoven material 10 of the present invention, the following factors are interrelated:

1) Temperature of bonding rolls 60 and 70;
2) Line speed of the forming process;
3) Nip pressure between the bonding rolls;
4) Diameter of the bonding rolls; and
5) Types of materials used in forming layers 12 and 22.

That is, modifying one or more of the above factors tends to affect the remaining factors as well. For example, an increase in the line speed of the forming process results in the layers of the nonwoven laminate being in contact with the bonding rolls for a shorter period of time. Consequently, the temperature of the bonding rolls may have to be increased to achieve the required degree of bonding of the two layers,

thereby compensating for the change in line speed.

As noted above, an important factor relating to the bonding of the two layers is the temperature at which the bonding rolls 60 and 70 are maintained. Naturally, temperatures below a certain point for each polymer will not effect any bonding, while temperatures above another point will melt too much of the web. Also, its has been observed that the temperature of the bonding rolls can affect both the tensile strength and softness of the nonwoven laminate produced. In particular, within a certain range, higher temperatures will produce a web with higher tensile strength. However, these same higher temperatures can produce a web with decreased softness. This is likely due to a higher and lower degree of bonding that occurs within this range of temperatures. That is, the higher temperatures likely result in more and stronger interfilament bonding that is beneficial to tensile strength and somewhat detrimental to softness. In addition, higher temperatures likely result in a less lofty, pillowed structure, as the thermoplastic fibers experience more shrinkage, adversely affecting the softness and cushiony feel of the nonwoven material 10.

It has further been observed that the temperature of the rolls can affect the formation of apertures in the bonded areas of the web. While the apertures formed in the bonded areas are not solely thermally produced, thermal bonding allows the respective layers to be compressed to a sufficient degree that mechanical aperturing may occur, as further described below.

In the embodiment shown, the bonding temperature for lower roll 60 can range from about 260°F. (127°C) to about 285°F. (141°C), with a temperature of about 265°F. (129°C) to about 275°F (135°C) being desireable, and the bonding temperature for upper roll 70 can range from about 270°F. (132°C) to about 320°F (160°C), with a temperature of about 290°F. (143°C) to about 315°F. (157°C) being desireable. It is important that the bonding roll that contacts the first nonwoven layer 12, which in this embodiment is lower bonding roll 60, have a

lower temperature than the bonding roll that contacts the second nonwoven layer 22, which in this embodiment is upper roll 70, such that the softness of the first layer 12 is not significantly reduced, while the thermoplastic fibers in the second layer 22 are sufficiently heated to thermally fuse with the thermoplastic fibers in the first layer 12. So long as the temperature of bonding roll 60 is maintained at a slightly lower temperature than the temperature at which the first layer 12 is bonded, assuming all other operating parameters are constant for the forming process described above, the softness of layer 12 will not change significantly.

Another important factor relating to the bonding of the two layers as well as the formation of apertures in the bonding regions is the line speed at which the respective bonding rolls are operated. In the embodiments shown, the rolls can operate at line speeds ranging from about 65 feet/min. (20 m/min.) to about 328 feet/min. (100 m/min.) or more. It has further been observed that aperture formation within the bonding regions can be significantly improved by employing different rotational surface speeds for the two bonding rolls. The difference in rotational surface speeds can differ from about 4% to about 20%, with about 5% to about 15% being conveniently employed. Either bonding roll may be employed with a higher rotational speed than the other bonding roll. While not wishing to be bound by any particular theory, it is believed that aperture formation is improved by operating the bonding rolls at different rotational speeds because the shearing forces tangential to the bonding roll surfaces in the thermally produced compacted bonding areas tear (mechanical aperturing) the nonwoven materials at the points of contact between the raised bonding patterns of the bonding rolls.

Another important factor relating to the bonding of the two layers is the diameter of each bonding roll. While in the embodiment shown (and in the ensuing Examples), the bonding rolls each are about 12 inches (305 mm) in diameter, bonding rolls having smaller or larger diameters are suitable for producing the nonwoven laminate of the present invention.

Moreover, the diameters of the bonding rolls need not be identical.

Another important factor relating to the bonding of the two layers and aperture formation within the bonding regions is the nip pressure between the bonding rolls. In the embodiment shown, the bonding rolls produce a nip pressure of from about 60 pli (10 kg/lcm) to about 400 pli (67 kg/lcm). It is likely that higher nip pressures will result in a less lofty, pillowed structure, adversely affecting the softness characteristics of the nonwoven material 10.

In the embodiment shown, after the layers 12 and 22 of nonwoven laminated material 10 are bonded by bonding rolls 60 and 70, nonwoven material 10 is wound on a take up roll (winder) 78. Alternatively, it may be desirable to design this apparatus to connect with a fabrication line for the end product. Higher tension on the take up roll 78 or fabrication line is another factor that is likely to adversely affect the loftiness of the nonwoven material 10 of this invention.

FIG. 4 is a cross-sectional view through a disposable diaper 100 including the nonwoven material 80 of the present invention positioned on the side of the diaper that will be placed next to the infant's body. In the embodiment shown, the nonwoven material 80 forms a body facing outer layer 12 comprising a bonded carded web formed of polypropylene fibers and an inner "surge" layer 22 comprising a substantially unbonded or unbonded carded web formed of a blend of polypropylene and polyester fibers as described above. The diaper further includes a liquid-permeable bodyside liner 82 formed, for example, of nonwoven spunbond or bonded carded web material, an absorbent core 84 formed, for example, of a blend of hydrophilic cellulosic woodpulp fluff and highly absorbent gelling particles (e.g., superabsorbents), a tissue layer 92 surrounding at least a portion of absorbent core 84, and a flexible, liquid-impermeable outer cover 86 formed, for example, of thin polyethylene film. As used herein, the term "superabsorbent" refers to a material, natural or synthetic, capable of absorbing or gelling at least about 10 times its

weight in liquid.

In the embodiment shown, the nonwoven material 80, which overlies liner 82, is substantially coextensive with the width of absorbent core 84, while the total area of liner 82 is substantially coextensive with the total area of outer cover 86. Alternatively, the nonwoven material 80 may be arranged to be generally coextensive with the outer cover 86. In other configurations, nonwoven material 80 may have a width that is less than the minimum width of absorbent core 84. In various optional configurations, the length of nonwoven material 80 may be equal to or less than the length of outer cover 86, although in the illustrated embodiment, the lengths of nonwoven material 80 and outer cover 86 are substantially equal.

As further shown in FIG. 4, nonwoven material 80 is positioned between two optional containment flaps 88 attached to the bodyside surface of liner 82. Suitable constructions and arrangements for containment flaps are described, for example, in U.S. Patent No. 4,704,116, issued November 3, 1987, to K. Enloe, the disclosure of which is hereby incorporated by reference.

Elastic members 90, which may optionally be included in the absorbent article, are disposed adjacent each longitudinal edge of diaper 100. Elastic members 90 are arranged to draw and hold the lateral, side margins of diaper 100 against the legs of the wearer. Additionally, elastic members (not shown) also may be disposed adjacent either or both of the end edges of diaper 100 to provide an elasticized waistband.

Nonwoven material 80 is connected to or otherwise associated with bodyside liner 82 or outer cover 86 in an operable manner. As used herein, the term "associated" encompasses configurations where nonwoven material 80 is directly joined to bodyside liner 82 by affixing marginal areas or intermediate areas of nonwoven material 80 directly to liner 82, and configurations where nonwoven material 80 is joined to outer cover 86, either directly or by affixing nonwoven material 80 to intermediate components that in turn are

affixed to outer cover 86. Nonwoven material 80 may be affixed directly to bodyside liner 82 or outer cover 86 by attachment means (not shown) such as adhesive, sonic bonds, thermal bonds or any other attachment means known to those of ordinary skill in the art. It is readily apparent that such attachment means may also be used to interconnect and assemble together the other component parts of the diaper 100. Fastening means (not shown) of known construction may also be optionally incorporated in the diaper construction shown.

FIG. 11b is a cross-sectional view through a disposable diaper 120 including the nonwoven material 128 of the present invention positioned on the diaper side of a liquid-permeable bodyside liner 146. In this embodiment, the nonwoven material 128 includes a reinforcement layer 147 comprising a bonded carded web formed of polypropylene fibers and a surge layer 149 comprising a substantially unbonded or unbonded carded web formed of a blend of polypropylene and polyester fibers, as described herein. In this embodiment, it is desireable to position the nonwoven material 128 such that surge layer 149 is adjacent the inner (diaper side) surface of bodyside liner 146, with reinforcement layer 147 facing the inner absorbent structure 132 of the disposable diaper, which is described in further detail below. Placing the surge layer 149 adjacent the inner surface of bodyside liner 146 provides improved inter-fiber pore size distribution and arrangement for fluid penetration and management purposes.

Considering disposable diaper 120 in further detail, and as shown in FIGS. 11a and 11c, diaper 120 comprises a liquid-impermeable backsheet or outer cover 130, which defines a front waistband region 123, a back waistband region 125 and an intermediate crotch region 131 that interconnects the front and back waistband sections. An absorbent structure, such as absorbent core 132, is superposed on outer cover 130, such that absorbent core 132 is sandwiched between nonwoven material 128 and outer cover 130.

In the embodiment shown, surge layer 149 of nonwoven material 128 has a basis weight of about 34 g/m^2 and is formed

of 40% 3.0 denier polypropylene fibers and 60% 6.0 denier polyester fibers. Reinforcement layer 147 has a basis weight of about 16.0 g/m^2 and is formed of 100% 3.0 denier polypropylene fibers. It should be recognized that by placing nonwoven material 128 within an absorbent article, such as diaper 120, variations in the basis weights and densities of the individual layers of nonwoven material 128 may be made primarily on the basis of improving functional performance, with fewer constraints based upon certain aesthetic and user comfort features, such as softness. For example, in this embodiment, because the nonwoven material 128 is internal and does not come into direct contact with the user's body, a lower basis weight material can be used and surge layer 149 does not have to be as soft.

FIG 11a is a representative plan view of diaper 120 in a flat-out, uncontracted state (i.e., with all elastic induced gathering and contraction removed) with the portion of diaper 120 that contacts the user facing the viewer. In the embodiment shown, diaper 120 has a width dimension 198 and a length dimension 199, a front waistband region 123, a back waistband region 125 and a crotch region 131. The waistband regions comprise those upper portions of diaper 120 that when worn, wholly or partially cover or encircle the waist or mid-lower torso of the wearer. The intermediate crotch region 131 lies between and interconnects waistband regions 123 and 125 and comprises that portion of diaper 120 that, when worn, is positioned between the legs of the wearer. Thus, the crotch region 131 is an area where repeated fluid surges can typically occur in diaper 120 or other disposable absorbent articles.

In the embodiment shown, diaper 120 has a bodyside liner 146 and an outer cover 130 that are substantially coextensive, and have length and width dimensions that are generally larger than those of absorbent core 132. Bodyside liner 146 is associated with and superimposed on outer cover 130, thereby defining a periphery 133 of diaper 120. The periphery 133 of the diaper is defined by the outer longitudinally extending

side edges 137 and the laterally extending end edges 122. Side edges 137 may be curvilinear and contoured to define leg openings for the diaper, as shown in Fig. 11b. End edges 122 as shown are straight, but optionally may be curvilinear. Although in the embodiment shown, bodyside liner 146 and outer cover 130 form a periphery 133 that is generally symmetrical, suitable non-symmetrical configurations may be employed as well. Diaper 120 further has a transverse center line 124 and a longitudinal center line 126.

Bodyside liner 146 may have different configurations. For example, bodyside liner 146 may have a width that is coextensive with the width of outer cover 130 over at least a portion of the width of the outer cover intermediate section. Alternatively, the bodyside liner width may be coextensive with the width of absorbent core 132 in at least the crotch section of the absorbent core.

Bodyside liner 146 presents a body-facing surface that is compliant, soft-feeling, and non-irritating to the wearer's skin. Bodyside liner 146 is typically employed to help isolate the wearer's skin from liquids held in absorbent core 132. Bodyside liner 146 comprises a material that is sufficiently porous to be liquid permeable, permitting liquid to readily penetrate through its thickness. A suitable bodyside liner 146 may be manufactured from a wide range of web materials, such as porous or reticulated foams, apertured plastic films, synthetic fibers (for example, polyester or polypropylene fibers), natural fibers (for example, wood or cotton fibers) or a combination of natural and synthetic fibers.

Various woven or nonwoven fabrics can be used for bodyside liner 146. For example, the bodyside liner may be composed of a meltblown or spunbonded web of polyolefin fibers. The bodyside liner alternatively may be a bonded-carded-web of natural and/or synthetic fibers.

The bodyside liner 146 may be composed of a substantially hydrophobic material, which may optionally be treated with a surfactant or otherwise processed to impart a desired level

of wettability and hydrophilicity. For example, bodyside liner 146 may comprise a nonwoven spunbond web produced from polypropylene material. Such a web may be composed of about 2-5 denier fibers, have a basis weight of about 17-51 g/m^2 and a density of about 0.032 to 0.043 g/cc. Bodyside liner 146 may also include about 0.11-0.43 weight percent of a suitable surfactant, such as Triton X-102 surfactant available from Rohm & Haas, a company having offices in Philadelphia, PA.

In the embodiment shown, diaper 120 includes a bodyside liner 146 that is substantially coextensive with the total area of outer cover 130 and is composed of a nonwoven, wettable, polypropylene spunbond web. The web has a basis weight of about 0.7 oz/yd^2 (about 24 g/m^2). In this embodiment, the bodyside liner further includes a plurality of apertures extending through the thickness of the liner material at least within the crotch portion of the web.

In the embodiment shown, containment flaps 162 are connected to the bodyside surface of bodyside liner 146 along the fixed edges 164 of the flaps. (See U.S. 4,704,116 identified above for suitable constructions and arrangements.) A movable edge 166 of each containment flap 162 includes a flap elastic member 168 comprising one or more individual strands of elastomeric material. For example, the elastic strands may be in a separated, generally parallel arrangement. Elastic member 192 is connected to the movable edge 166 of the containment flap 162 in an elastically contractible condition such that the contraction of the elastic components thereof gathers and shortens the edge of the containment flap, thereby causing the movable edge of each containment flap to position itself in a spaced relation away from the surface of bodyside liner 146 toward a generally upright configuration. The containment flaps may be constructed of a material that is the same as or different than the material comprising bodyside liner 146 and may be liquid-permeable or liquid-impermeable. For example, in the embodiment of diaper 120 shown, containment flaps 162 may be formed of liquid-impermeable or

liquid-permeable spunbond-meltblown-spunbond fibrous nonwoven laminate material, such as described in U.S. Patent No. 4,041,203 to Brock et al., the disclosure of which is hereby incorporated by reference.

Outer cover 130 may be composed of a substantially liquid impermeable material, and is typically manufactured from a thin plastic film or other flexible liquid-impermeable material. As used herein, the term "flexible" refers to materials that are compliant and will readily conform to the general shape and contours of the user's body. Outer cover 130 prevents the exudates contained in absorbent core 132 from wetting articles such as bedsheets and overgarments that contact diaper 120. For example, outer 130 may be a polyethylene film having a thickness of from about 0.012 mm (0.5 mil) to 0.051 mm (2.0 mils). Depending upon cost constraints and strength requirements, a typical polyethylene film has a thickness of about 1.0 mil to about 1.25 mils. Alternative constructions of the outer cover may comprise a woven or nonwoven fibrous web layer that has been constructed or treated to impart the desired level of liquid impermeability.

A suitable material for outer cover 130 comprises a polymer film, such as polyethylene film available from Edison Plastics, a business having offices located in South Plainfield, New Jersey. The polymer film outer cover may also be embossed and/or matte finished to provide a more aesthetically pleasing appearance.

Outer cover 130 may optionally be composed of a vapor or gas permeable, "breathable" material that permits vapors or gas to escape from absorbent core 132 while substantially preventing liquid exudates from passing through the outer cover 130. For example, outer cover 130 may comprise a microporous, polymer film, or a nonwoven fabric that has been coated or otherwise treated to impart desired levels and combinations of liquid impermeability and vapor or gas permeability.

The shape and size of outer cover 130 are determined by the

size and contour of the absorbent core 132 and by the particular absorbent article design selected. Outer cover 130 may, for example, have a generally T-shape, I-shape or modified hourglass shape and may extend beyond the terminal edges of absorbent core 132 by a selected distance, such as 1.3 cm to 2.5 cm (0.5 to 1.0 inch).

Bodyside liner 146 and outer cover 130 are connected or otherwise associated together in an operable manner, as defined herein. Bodyside liner 146 and outer cover 130 may be affixed directly to each other in the diaper periphery 133 by attachment means (not shown) such as adhesive, sonic bonds, thermal bonds or any other attachment means known in the art. For example, a uniform continuous layer of adhesive, a patterned layer of adhesive, or an array of separate lines, swirls or spots of construction adhesive may be used to affix bodyside liner 146 to outer cover 130. The above-described attachment means may likewise be employed to interconnect and assemble together the other component parts of the diaper.

Fastening means, such as adhesive tape tab fasteners 136, are typically applied to the back waistband region 125 of diaper 120 in order to provide a mechanism for holding the diaper on the user. Tape tab fasteners 136, shown in their inwardly-folded storage position, can be any of those well known in the art and are typically attached to the corners of diaper 120 as shown in FIGS 11a and 11c. The adhesive taping system may be configured to be refastenable and may include one or more supplemental landing zone patches (not shown). The tape landing zone material, such as polypropylene film, may have an embossed surface and may be connected to either the inside or outside surface of the outer cover. For example, see U.S. Patent No. 4,753,649 to Pazdernik and U.S. Patent No. 4,296,750 to Woon et al. Alternatively, mechanical fasteners, such as belts, hook-and-loop fasteners, mushroom-and-loop fasteners, snaps, pins or buckles may be used rather than, or in combination with, adhesives and other means. It may further be possible to dispense with fastening means in a given absorbent article design.

Elastic members 134 and 135, if included in the particular article, may be disposed adjacent the periphery 133 of diaper 120. Along each longitudinal side edge 137, elastic members 196 are arranged to draw and hold the lateral, side margins of diaper 120 against the legs of the user. Additionally, elastic members 135 may also be disposed adjacent either or both of the end edges 122 of diaper 120 to provide an elasticized waistband. Elasticized leg gathers and waist gathers are typically used in conventional diapers to reduce leakage caused by inadequacies of conventional absorbent structures and materials. Accordingly, absorbent articles of the present invention may be advantageously configured to lessen reliance on the elasticized gathers for liquid containment purposes.

Elastic members 134 and 135 are secured to diaper 120 in an elastically contractible condition so that in a normal, under-strain configuration, as shown in FIG. 11c, the elastic members effectively contract against and effectively gather portions of diaper 120. The elastic members can be secured in an elastically contractible condition in at least two ways. For example, the elastic members may be stretched and secured while diaper 120 is in an uncontracted condition. Alternatively, diaper 120 may be contracted, for example, by pleating, and the elastic members secured and connected to diaper 120 while the elastic members are in their unrelaxed or unstretched condition. Still other means, such as heat-shrink elastic materials, or stretch-bonded nonwoven fibrous laminate materials as described in U.S. Patent No. 4,720,415, the disclosure of which is incorporated herein, may be used to gather the diaper.

Elastic members 134 may, as shown in this embodiment, extend essentially the length of the crotch region 131 of diaper 120. Alternatively, elastic members 134 may extend the entire length of diaper 120, or any other length suitable for providing the arrangement of elastically contractible lines desired for the particular diaper or other absorbent article design.

Elastic members 134 may have any of a multitude of configurations. For example, the width of the individual elastic members 134 may be varied from 0.25 mm (0.01 inch) to 25 mm (1.0 inch) or more. Elastic members 134 may comprise a single strand of elastic material or may comprise several parallel or non-parallel strands of elastic material. Elastic members 134 may be applied in a rectilinear or curvilinear arrangement. Elastic members 134 may be affixed to the diaper in any of several ways known in the art. For example, elastic members 134 may be ultrasonically bonded, heat and pressure sealed using a variety of bonding patterns, or adhesively bonded to diaper 120.

In the embodiment shown, leg elastic members 134 may comprise a carrier sheet to which is attached a grouped set of elastic composed of a plurality of individual, separated elastic strands. For example, the carrier sheet can comprise a strip of 0.75 mil thick, polypropylene film, and the elastic strands can comprise spandex elastomeric fibers, such as Lycra® available from DuPont, a business having office in Wilmington, DE. In the embodiment shown, each elastic strand is about 940 decitex, although strands of greater and lesser thickness can also be suitable. The individual elastic strands may be spaced about 2-4 mm apart and can be attached to the carrier sheet by any known means, such as, with a swirl pattern of hot melt adhesive.

Absorbent core 132 is ordinarily positioned adjacent outer cover 130 to form the various desired configurations of diaper 120. The absorbent core is generally compressible, conformable, non-irritating to the wearer's skin, and capable of absorbing and retaining liquid body exudates. For purposes of this invention, the absorbent core can comprise a single, integral piece of material, or alternatively may comprise a plurality of individual separate pieces of material.

Absorbent core 132 may be manufactured in a wide variety of sizes and shapes (for example, rectangular, trapezoidal, T-shape, I-shape, hourglass shape, etc.) and from a wide variety of materials. The size and the absorbent capacity of

absorbent core 132 should be compatible with the size of the intended user and the liquid loading imparted by the intended use of the absorbent article. Further, the size and the absorbent capacity of absorbent core 132 can be varied to accommodate users ranging from infants to adults. In addition, it has been found that with the present invention, the density and/or basis weight of the absorbent core 132, as well as their relative ratios, can be varied.

Varied types of wettable, hydrophilic fibrous material can be used in the component parts of absorbent core 132. Examples of suitable fibers include naturally occurring organic fibers composed of intrinsically wettable material, such as cellulosic fibers; synthetic fibers composed of cellulose or cellulose derivatives, such as rayon fibers; inorganic fibers composed of an inherently wettable material, such as glass fibers; synthetic fibers made from inherently wettable thermoplastic polymers, such as particular polyester or polyamide fibers; and synthetic fibers composed of a nonwettable thermoplastic polymer, such as polypropylene fibers, that have been hydrophilized by appropriate means. The nonwettable fibers may be hydrophilized, for example, by treatment with silica, treatment with a material which has a suitable hydrophilic moiety and is not readily removable from the fiber, or by sheathing the nonwettable, hydrophobic fiber with a hydrophilic polymer during or after the formation of the fiber. For purposes of this invention, it is contemplated that selected blends of the various types of fibers mentioned above may also be employed.

As used herein, the term "hydrophilic" generally describes fibers or the surfaces of fibers that are wetted by the aqueous liquids in contact with the fibers. The degree of wetting of the materials can, in turn, be described in terms of the contact angles and the surface tensions of the liquids and materials involved. Equipment and techniques suitable for measuring the wettability of particular fibers or blends of fibers can be provided by a Cahn SFA-222 Surface Force Analyzer system. When measured with this system in accordance

with the procedure described in detail herein below, fibers having contact angles less than 90 degrees are referred to as "wettable," while fibers having contact angles greater than 90 degrees are referred to as "nonwettable."

Suitable absorbent gelling materials, commonly referred to as "superabsorbents," can be inorganic materials such as silica gels or organic compounds such as cross-linked polymers. Cross-linking may be by covalent, ionic, Van der Waals or hydrogen bonding. Examples of absorbent gelling polymer materials include polyacrylamides, polyvinyl alcohol, ethylene maleic anhydride copolymers, polyvinyl ethers, hydroxypropyl cellulose, carboxymal methyl cellulose, polyvinylmorpholinone, polymers and copolymers of vinyl sulfonic acid, polyacrylates, polyacrylamides, polyvinyl pyrrolidone and the like. Further polymers suitable for use in the absorbent core include hydrolyzed, acrylonitrile grafted starch, acrylic acid grafted starch, polyacrylates and isobutylene maleic anhydride copolymers or mixtures thereof. Other suitable hydrogel-forming polymers are disclosed in U.S. Patent No. 3,902,236 to Assarson et al. Processes for preparing hydrogel-forming polymers are disclosed in U.S. Patent No. 4,076,663 to Masuda et al. and U.S. Patent No. 4,286,082 to Tsubakimoto et al.

The absorbent gelling material is generally in the form of discrete particles. The particles can be of any desired shape. Particles having an average size of from about 20 microns to about 1 millimeter can be advantageously employed. "Particle size" as used herein means the weighted average of the smallest dimension of the individual particles.

Examples of suitable commercially available superabsorbent gelling materials include DOW 535, distributed by Dow Chemical Company; SANWET IM 5000P, distributed by Hoechst Celanese Company; and FAVOR SAB 835, 836 or 870, distributed by Stockhausen.

Absorbent core 132 may include a wrapsheet layer which at least partially overwraps the absorbent core. The wrapsheet may comprise, for example, a hydrophilic high wet-strength

envelope web, such as a high wet strength tissue or a synthetic fibrous web, and can help minimize the migration of particles of absorbent gelling material out from the absorbent core 132. Such an overwrapping web can also increase the in-use integrity of the absorbent core. The web can be glued to the absorbent core and to other components of the absorbent article construction.

Nonwoven material 128 may be of any desired shape consistent with the liquid handling and absorbency requirements of the absorbent core 132. Suitable shapes include, for example, circular, rectangular, triangular, trapezoidal, oblong, dog-boned, hourglass-shaped or oval. The nonwoven material 128 is advantageously dimensioned to maximize the contacting, liquid communicating surface area between the nonwoven material and the absorbent core. For example, in the embodiment shown of diaper 120, the nonwoven material 128 can be rectangular-shaped with a top surface area of ranging from about 24.0 to 56.0 in^2 (about 154.8 to 361.2 cm^2).

Nonwoven material 128 should have an operable level of density and basis weight to quickly collect and temporarily hold liquid surges and to rapidly transport the liquid from the initial entrance point to the absorbent core 132 of diaper 120. Such a configuration can help prevent the liquid from pooling and collecting on the bodyside liner 146 and can thereby reduce the feeling of wetness by the user.

Nonwoven material 128 may be positioned along the entire length of the absorbent core 132 and the diaper 120. Alternatively, nonwoven material 128 may advantageously extend along only a portion of the diaper length or along only a part of the length of the absorbent core 132. Similarly, nonwoven material 128 may extend along only a part of the diaper width or along only a part of the width of the absorbent core. For example, nonwoven material 128 may be up to about 4.0 inches shorter than absorbent core 132 and transversely centered within the front section of the diaper, but offset toward the front waistband of the diaper with the front edge of nonwoven material 128 placed from about 0.5 inch to about 1.5 inches

closer to the transverse center line of the diaper than the front edge of absorbent core 132.

With respect to disposable absorbent articles, wherein reduced bulk or minimum cost may be important, nonwoven material 128 can advantageously be employed without taking on the entire overall shape of the absorbent article. Rather, nonwoven material can be cut and placed such that it is generally located only in the genital region of the user.

Surge layer 149 of nonwoven material 128 is placed in liquid communicating contact with bodyside liner 146. Nonwoven material 128 may be suitably attached or bonded to bodyside liner 146 by known attachment means, such as, for example, by applying adhesive swirl lines along the length of either the inner (diaper) side of bodyside liner 146 and/or to the surface of surge layer 149 facing bodyside liner 146. The attachment means for bonding nonwoven material 128 and bodyside liner 146 should be configured to maintain the bulky, lofty or pillow-like nature of nonwoven material 128. For example, adhesive swirl lines having an overall width of about 0.5 to 0.75 inch may be applied only along the side edges of surge layer 149 extending along the length of nonwoven material 128, with no adhesive being applied along the center portion or ends of surge layer 149, which allows the nonwoven material 128 to retain the bulkiness needed to achieve its required functionality.

It is contemplated that nonwoven material 128 constructed in accordance with the present invention will be tailored and adjusted to accommodate various levels of performance demand imparted during actual use. For example, mild urinary incontinence and menstrual flow pads involve different delivery rates, volumes and timing than infant urine insults. Moreover, the liquid in the surge may vary in terms of the liquid viscosity, surface tension, temperature and other physical properties that could affect the performance of the fabric in the various actual product end usages.

The nonwoven material 128 of diaper 120 comprises a resilient fibrous structure. The nonwoven material should

stay sufficiently open under load to maintain void volume in the material, resist collapsing when wetted to better release liquid and to better allow the material to be desorbed and be regenerating after being wetted to preserve void volume capacity for successive insult(s). The compression-resistant characteristics of nonwoven material 128 enable multiple insult fluid reservoir functionality. The quilted structure of nonwoven material 128 further enables air circulation during use.

While particular configurations of the component parts of diapers 100 and 120 are shown in FIGS. 4 and 11a-c, respectively, these components may be assembled into a variety of well-known diaper configurations. It should be further recognized, however, that in disposable absorbent articles other than diapers, individual components may be optional, depending upon their intended end uses.

The nonwoven material of the present invention may alternatively be formed of a single fibrous layer, rather than the fibrous laminate heretofore described. In such an embodiment, the first fibrous layer 12 of nonwoven material 10 shown in FIG. 1 (or the reinforcement layer 147 of nonwoven material 128 shown in FIG. 11b) is not required. Due to the absence of this first fibrous layer, certain process parameters and properties of the nonwoven material of this embodiment must be modified in order to provide desireable liquid management and distribution, as well as structural integrity needed for high speed commercial processing of disposable absorbent articles. This embodiment of the present invention finds particular application in absorbent articles such as disposable diaper 120 shown in FIGS. 11A-11C and described in the accompanying text, wherein the nonwoven material of this invention is positioned adjacent the inner (diaper side) surface of bodyside liner 146, although its functionality is not limited to such absorbent articles or absorbent article constructions.

FIG. 12 is a perspective view of this embodiment of the present invention and FIG. 13 is a cross-sectional view of the

nonwoven material of FIG. 12. The nonwoven material 200 comprises a single nonwoven layer 202, having an upper surface 204 and a lower surface 206. In this embodiment, a plurality of thermal fusion bonds in a spaced apart bonding pattern 208 extend through the thickness of the nonwoven material 200 to thermally fuse or bond fibers together within the bonding regions 208. Bonding of the fibers of nonwoven material 200 is substantially limited to the bonding regions 208. Outside of the bonding regions 208, individual fibers are only lightly bonded to one another by fiber fusing from thermal energy, resulting the bonding regions 208 being separated or "spaced apart" by lightly bonded fibers spans or areas 212. Apertures 210 are formed within the bonding regions 208 to improve the liquid distribution and management properties of material 200.

The single fibrous layer 202 of this embodiment may be formed by any suitable natural or synthetic fibers, or homogeneous blends thereof, into any appropriate structure, although as shown and described herein, these fibers are formed into a nonwoven layer. Nonwoven layer 202 can be prepared from noncontinuous fibers, continuous filaments or a combination thereof. Examples of suitable fibers include naturally occurring organic fibers that are intrinsically wettable, such as cellulosic fibers; synthetic fibers composed of cellulose or cellulose derivatives, such as rayon fibers; inorganic fibers composed of an inherently wettable material, such as glass fibers; synthetic fibers made from inherently wettable thermoplastic polymers, such as particular polyester or polyamide fibers; and synthetic fibers composed of a nonwettable thermoplastic polymer, such as polypropylene fibers, which have been hydrophilized by appropriate means. Blends or mixtures of the various types of fibers described above may also be employed.

Conventional carded web techniques may be advantageously employed in forming nonwoven layer 202, however, spunbonding, meltblowing, air-laying and other techniques known to those of ordinary skill in the art also may be utilized. In the embodiment shown in FIGS. 12 and 13, conventional carding

machines can be employed to form a fibrous carded web. The fibers of the carded web may be aligned or unaligned.

Commercially available thermoplastic polymeric materials having any suitable fiber morphology (as described above) can be employed in forming nonwoven material 200. Particularly, bicomponent fibers, such as polyethylene-polyester sheath-core fibers, polyethylene-polypropylene sheath-core fibers, and low melt polyester sheath-core fibers, may be advantageously employed in forming this embodiment of the present invention. Suitable polyethylene-polyester sheath-core bicomponent fibers are available from BASF Corp., Fibers Division, having offices in Enka, North Carolina. Suitable polyethylene-polypropylene sheath-core bicomponent fibers are available from Chisso Corp., having offices in Osaka, Japan. Suitable low-melt polyester sheath-polyester core bicomponent fibers are available from Sam Yang Co. Ltd., having offices in Seoul, South Korea.

This embodiment of nonwoven material 200 can be generally described as a carded web made of staple thermoplastic fibers. More specifically, nonwoven material 200 is a carded web of a blend of polypropylene and polyester single component fibers. While this embodiment of the present invention will be described in detail, nonwoven materials formed of a single thermoplastic fiber type are considered within the scope of this invention.

The ratio of thermoplastic fibers in nonwoven material 200 can be varied according to the intended end-use application of the material. For example, the ratio of polypropylene to polyester fibers by total weight of nonwoven material 200 can range from about 70:30 to about 25:75, with about 50:50 being the ratio for the embodiment shown.

Other examples of fiber type combinations suitable for this embodiment of the present invention include blends of standard polyester single component fibers used, for example, in textile applications and polyester sheath-core bicomponent fibers wherein the polyester sheath material is a polymer having a lower softening temperature than the polyester core

material, such as LM-51 bicomponent fibers available from Sam Yang Co. Ltd. The term "low-melt" in this context in intended to refer to thermoplastic materials or fibers having a softening temperature below 392°F (200°C), and typically between 266°F (130°C) and 302°F (150°C). Or, three fiber combinations including polypropylene and polyester fibers with from about 10% to about 20% cellulose or natural fibers by total weight of the nonwoven material may be utilized.

The fiber sizes, basis weight and density of nonwoven material 200 also can be readily varied depending upon the end-use application of the material. For example, in a disposable diaper, such as diaper 120 shown in FIGS 11A-C, in which nonwoven material 200 would be placed within the internal absorbent structure of the disposable diaper, the polypropylene fibers can range in diameter from about 1.0 denier (12.5 microns in diameter) to about 10.0 denier (39.4 microns), with a fiber size from about 2.0 denier (17.6 microns) to about 6.0 denier (30.5 microns) being desireable. Polypropylene fibers having larger fiber diameters, in the range of about 3.0 denier (21.6 microns) to about 10.0 denier (39.4 microns), are considered more suitable for forming nonwoven material 200 when used in sanitary napkins and like products, wherein the viscosity, surface tension and other physical properties of the liquid contacting the nonwoven material differs.

The polyester fibers in nonwoven material 200 can have fiber diameters in the range of about 1.0 denier (10.1 microns) to about 9.0 denier (30.4 microns), with about 6.0 denier (24.8 microns) being suitable.

Nonwoven material 200 of this embodiment can have a basis weight ranging from 20 g/m^2 (0.6 oz/yd^2) to about 100 g/m^2 (2.9 oz/yd^2), with about 40 g/m^2 (1.2 oz/yd^2) to about 70 g/m^2 (2.0 oz/yd^2) being desireable. Nonwoven material 200 has a generally uniform thickness that can range from about 0.030 in. (0.762 mm) to about 0.065 in. (1.651 mm), with a thickness of about 0.035 in. (0.889 mm) to about 0.040 in. (1.016 mm)

being desireable. The density of nonwoven material 200 ranges from about 0.030 g/cc to about 0.080 g/cc, with about 0.050 g/cc to about 0.060 g/cc being desireable.

Referring again to FIG. 12, this embodiment of nonwoven material 200 includes a series of bonds forming a spaced apart bonding pattern 208 extending through the thickness of the nonwoven material and bonding individual thermoplastic fibers together within the bonding regions 208. The spaced apart bonding regions 208 may be produced by any suitable method of bonding the fibers forming nonwoven material 200 to yield a nonwoven material having the liquid management and distribution and other properties described herein. Thermal bonding, essentially as described hereinabove, is considered a useful method of forming the spaced apart bonding pattern 208 in this embodiment of the present invention as well.

In this embodiment of the present invention, the absence of a first fibrous (reinforcement) layer may be compensated for by altering certain aspects of the forming process. This yields a single layer nonwoven material, such as nonwoven material 200, with sufficient structural integrity and mechanical strength for further processing, while maintaining the liquid distribution and management and other properties required for the desired end-use application.

One such forming condition is the percent bond area of the nonwoven material, which refers to the surface area of the upper surface 204 or lower surface 206 of nonwoven material 200 that is occupied by bonds within the bonding regions 208. As shown in FIG. 12, nonwoven material 200 has a spaced apart bonding pattern 208 disposed across its outer surfaces and the ratio of the surface area (upper or lower) occupied by bonding regions 208 to the total surface area of the upper or lower surface is the percent bond area for nonwoven material 200. In the embodiment shown, the percent bond area can range from about 4% to about 35%, with more than about 6% to about 15% being desireable. As noted above, while a hexagonal (honeycomb-like) bonding pattern is shown, other suitable bonding patterns may be utilized in forming nonwoven material

200.

In forming the embodiment shown of nonwoven material 200, the alteration of the percent bond area can be effected by altering the raised bonding patterns on one or both thermal bonding rolls to achieve the desired percent bonding area for the nonwoven material. For example, by increasing the percent bond area (the ratio of the surface area of the raised bonding pattern to the total outer surface area of the bonding roll) of one bonding roll, such as bonding roll 60 shown in FIGS. 3 and 3A, or both bonding rolls, the percent bond area of nonwoven material 200 can be sufficiently increased to ensure sufficient integrity of the nonwoven material for further processing and its intended use, without completely sacrificing desireable loftiness and softness qualities of the nonwoven material. Again referring to the thermal bonding rolls shown in FIGS. 3 and 3A as representative of bonding rolls used in forming the nonwoven material 200 of this embodiment, the percent bond area of lower roll 60 can range from about 9% to about 70%, with about 33% to about 45% being desireable, and the percent bond area of upper roll 70 can range from about 10% to about 50%, with about 18% to about 24% being desireable.

As in forming the previously described nonwoven laminated material of the present invention, the raised bonding patterns of the two bonding rolls can be combined to optimize the number and location of apertures 210 within the bonding regions 208 of nonwoven material 200. If, for example, the percent bond area of one or both bonding rolls is increased by reducing the size or spacing of the raised bonding patterns 208 on the outer surfaces thereof, the increased number of apertures 210 formed within the boding regions 208 will result in nonwoven material 200 having a higher number of apertures per unit of square area. Increasing the number of apertures results in more channels extending through the thickness of nonwoven material 200, which affects both liquid permeability and air permeability and circulation.

Likewise, other processing conditions can affect

optimization of this embodiment of the present invention. For example, the bonding temperature at which the thermal bonding rolls are maintained is an important factor in forming nonwoven material 200. In forming nonwoven material 200 using thermal bonding rolls such as those shown in FIGS. 3 and 3A, the bonding temperature for lower roll 60 can range from about 260°F (127°C) to about 450°F (232°C), with a temperature of about 275°F (135°C) to about 400°F (204°C) being desireable. The bonding temperature for upper roll 70 can range from about 270°F (132°C) to about 450°F (232°C), with a temperature of about 275°F (135°C) to about 400°F (204°C) being desireable.

Another important factor relating to the bonding of fibers forming the nonwoven material 200, as well as the formation of apertures within the bonding regions 208, is the line speed at which the nonwoven material 200 passes through the thermal bonding rolls. For the embodiment shown, the nonwoven material 200 can be produced from a single carding machine at line speeds varying from about 55 feet/min. (17 meters/min.) to about 328 feet/min. (100 meters/min.), with a line speed of from about 98 feet/min. (30 meters/min.) to about 230 feet/min. (70 meters/min.) being desireable. It is recognized in the art of forming carded webs that line speed is a function of, and may be limited by, the carding machine fiber throughput for a carded web having a given basis weight. Thus, employing additional carding machines may allow fiber throughput, and therefore line speed of the fibrous web, to be increased for a given basis weight.

As described above, aperture formation in the bonding regions 208 of the nonwoven material 200 of this embodiment likewise is dependent upon several process conditions, including the relative rotational speeds of the thermal bonding rolls. Differences in the rotational speeds of the two bonding rolls, ranging from about 4% to about 50%, and particularly from about 8% to about 20%, can result in significant improvements in aperture formation within bonding regions 208 of nonwoven material 200.

The nip pressure produced between the thermal bonding rolls

also can affect the bonding of fibers forming nonwoven material 200 and aperture formation within the bonding regions. In this embodiment, the bonding rolls, as shown for example in FIGS 3 and 3A, can produce a nip pressure of from about 100 pli (17.5 kg/lcm) to about 418 pli (70 kg/lcm), with a range between 286 pli (50 kg/lcm) and 343 pli (60 kg/lcm) being advantageously employed.

Single layer nonwoven materials formed in accordance with this embodiment of the present invention have sufficient integrity and mechanical strength to avoid web breakage during high speed manufacturing processes used for producing disposable absorbent articles, notwithstanding the absence of a pre-bonded fibrous reinforcement layer. In addition to the cost savings directly attributable to elimination of such reinforcement layer, the nonwoven material of this embodiment yields improved liquid management and distribution properties.

Unlike the embodiment of the present invention described above, wherein a prebonded first fibrous layer is bonded to a substantially unbonded second fibrous layer, the nonwoven material 200 of this embodiment is a single fibrous layer. The absence of a prebonded first fibrous layer results in nonwoven material 200 having a more open fiber structure. The porosity of nonwoven materials made in accordance with this embodiment of the present invention have been measured ranging from about 480 cfm to about 700 cfm. Such an open fiber structure yields greater void volumes between individual fibers forming the fibrous layer and, consequently, more space between fibers for liquid to fill up. The open fiber structure of nonwoven material 200 contributes to its improved liquid intake characteristics. Similarly, the open fibrous structure of this embodiment of the present invention results in improved air permeability and circulation properties, which can provide significant skin care benefits, such as reducing rashes, to users of absorbent articles incorporating nonwoven material 200.

These and other properties of this embodiment of the present

invention are described in greater detail in the following examples, which are provided to give a better understanding of this invention. The particular compositions, proportions, materials and parameters are exemplary and are not intended to specifically limit the scope of the present invention.

EXAMPLES

EXAMPLE A

A single fibrous layer was formed of 50% polypropylene fibers (3.0 denier PP-196 manufactured by Hercules, Inc. having offices in Wilmington, DE) and 50% polyester fibers (6.0 denier SD-10 manufactured by Sam Yang Co. Ltd. having offices in Seoul, South Korea) by blending on a conventional carding machine. This fibrous web had an average basis weight of 52.10 g/m^2. The fibers of the fibrous layer were bonded together by heated bonding rolls, with the lower roll having a spaced apart bonding pattern on the outer surface thereof with a percent bond area of about 37% and the upper roll having raised bonding points on the outer surface thereof with a percent bond area of about 19%. The lower roll was maintained at a bonding temperature of about 288 °F (142 °C) and the upper roll was maintained at a bonding temperature of about 292 °F (144 °C). The line speed of the fibrous layer passing-through the nip formed by the bonding rolls was about 75 feet/min. (23 m/min.). A rotational speed differential of about 16% was maintained between the bonding rolls. The nip pressure between the bonding rolls was about 375 pli (63 kg/lcm). The thermobonding process yielded a nonwoven material having a spaced apart bonding pattern with apertures formed within the bonding regions and a percent bond area of about 7%.

EXAMPLE B

A single fibrous layer was formed of 50% polypropylene fibers (3.0 denier PP-196) and 50% polyester fibers (6.0 denier SD-10) by blending on a conventional carding machine. This fibrous web had an average basis weight of 56.64 g/m^2.

The fibers of the fibrous layer were bonded together under the same processing conditions as in Example A. The thermobonding process yielded a nonwoven material having a spaced apart bonding pattern with apertures formed within the bonding regions and a percent bond area of about 7%.

EXAMPLE C

A single fibrous layer was formed of 50% polypropylene fibers (2.2 denier PP-196) and 50% polyester fibers (6.0 denier SD-10) by blending on a conventional carding machine. This fibrous web had an average basis weight of 55.80 g/m^2. The fibers of the fibrous layer were bonded together under the same processing conditions as in Example A. The thermobonding process yielded a nonwoven material having a spaced apart bonding pattern with apertures formed within the bonding regions and a percent bond area of about 7%.

EXAMPLE D

A single fibrous layer was formed of 50% polypropylene fibers (2.2 denier PP-196) and 50% polyester fibers (6.0 denier SD-10) by blending on a conventional carding machine. This fibrous web had an average basis weight of 68.94 g/m^2. The fibers of the fibrous layer were bonded together under the same processing conditions as in Example A. The thermobonding process yielded a nonwoven material having a spaced apart bonding pattern with apertures formed within the bonding regions and a percent bond area of about 7%.

EXAMPLE E

A single fibrous layer was formed of 50% polypropylene fibers (2.2 denier T-107, a non-commercial experimental fiber manufactured by Hercules, Inc. having a higher wettability than PP-196 fibers) and 50% polyester fibers (6.0 denier SD-10) by blending on a conventional carding machine. This fibrous web had an average basis weight of 59.63 g/m^2. The fibers of the fibrous layer were bonded together under the

same processing conditions as in Example A. The thermobonding process yielded a nonwoven material having a spaced apart bonding pattern with apertures formed within the bonding regions and a percent bond area of about 7%.

EXAMPLE F

A single fibrous layer was formed of 50% polypropylene fibers (2.2 denier T-108, a non-commercial experimental fiber manufactured by Hercules, Inc. having twice the wettability of T-107 fibers referred to in Example E above) and 50% polyester fibers (6.0 denier SD-10) by blending on a conventional carding machine. This fibrous web had an average basis weight of 65.95 g/m^2. The fibers of the fibrous layer were bonded together by heated bonding rolls, with the lower roll having a spaced apart bonding pattern on the outer surface thereof with a percent bond area of about 37% and the upper roll having raised bonding points on the outer surface thereof with a percent bond area of about 19%. The lower roll was maintained at a bonding temperature of about 300 °F (149 °C) and the upper roll was maintained at a bonding temperature of about 295 °F (146 °C). The line speed of the fibrous layer passing through the nip formed by the bonding rolls was about 75 feet/min. (23 m/min.). A rotational speed differential of about 16% was maintained between the bonding rolls. The nip pressure between the bonding rolls was about 375 pli (63 kg/lcm). The thermobonding process yielded a nonwoven material having a spaced apart bonding pattern with apertures formed within the bonding regions and a percent bond area of about 7%.

EXAMPLE G

A single fibrous layer was formed of 50% polypropylene fibers (2.2 denier T-186 manufactured by Hercules, Inc. having a durable hydrophilic finish) and 50% polyester fibers (6.0 denier SD-10) by blending on a conventional carding machine. This fibrous web had an average basis weight of 64.33 g/m^2.

The fibers of the fibrous layer were bonded together under the same processing conditions as in Example F. The thermobonding process yielded a nonwoven material having a spaced apart bonding pattern with apertures formed within the bonding regions and a percent bond area of about 7%.

EXAMPLE H

A single fibrous layer was formed of 50% polypropylene fibers (2.0 denier T-1001 manufactured by Kolon Merak, having offices in Seoul, South Korea) and 50% polyester fibers (6.0 denier SD-10) by blending on a conventional carding machine. This fibrous web had an average basis weight of 55.8 g/m^2. The fibers of the fibrous layer were bonded together by heated bonding rolls, with the lower roll having a spaced apart bonding pattern on the outer surface thereof with a percent bond area of about 42.7% and the upper roll having raised bonding points on the outer surface thereof with a percent bond area of about 19%. The lower roll was maintained at a bonding temperature of about 361 °F (183 °C) and the upper roll was maintained at a bonding temperature of about 367 °F (186 °C). The line speed of the fibrous layer passing through the nip formed by the bonding rolls was about 115 feet/min. (35 m/min.). A rotational speed differential of about 16.5% was maintained between the bonding rolls. The nip pressure between the bonding rolls was about 314 pli (56 kg/1cm). The thermobonding process yielded a nonwoven material having a spaced apart bonding patter with apertures formed within the bonding regions and a percent bond area of about 8%.

EXAMPLE I

A single fibrous layer was formed of 50% polypropylene fibers (2.2 denier PP-196) and 50% polyester fibers (6.0 denier SD-10) by blending on a conventional carding machine. This fibrous web had an average basis weight of 58.7 g/m^2. The fibers of the fibrous layer were bonded together by heated bonding rolls, with the lower roll having a spaced apart

bonding pattern on the outer surface thereof with a percent bond area of about 42.7% and the upper roll having raised bonding points on the outer surface thereof with a percent bond area of about 19%. The lower roll was maintained at a bonding temperature of about 340 °F (171 °C) and the upper roll was maintained at a bonding temperature of about 349 °F (176 °C). The line speed of the fibrous layer passing through the nip formed by the bonding rolls was about 115 feet/min. (35 m/min.). A rotational speed differential of about 16.5% was maintained between the bonding rolls. The nip pressure between the bonding rolls was about 314 pli (56 kg/lcm). The thermobonding process yielded a nonwoven material having a spaced apart bonding patter with apertures formed within the bonding regions and a percent bond area of about 8%.

The resultant nonwoven materials of the above examples had the properties set forth in the following table:

TABLE A

Example	Basis Weight (g/m^2)	Thick-ness (in.)	Density (g/cc)	Tensile (g/in.) MD	Tensile (g/in.) CD	% Elongation MD
A	52.10	0.035	0.058	1098	111	38.16
B	56.64	0.039	0.057	1384	180	50.11
C	55.80	0.039	0.056	1148	94	35.50
D	68.94	0.055	0.049	1310	136	36.45
E	59.63	0.052	0.049	487	91	22.72
F	65.95	0.052	0.049	555	57	26.05
G	64.33	0.050	0.050	1168	114	34.23
H	55.8	0.043	0.051	697.1	125.9	22.9
I	58.7	0.039	0.059	715.5	115.8	26.54

Flowback and liquid intake time values, determined generally in accordance with the test procedures described in detail hereinbelow, also were determined for the single layer nonwoven materials of the above Examples. In the sample diapers tested using the Fluid Intake and Flowback Evaluation (FIFE) test, no separate or laminated liner layer or material was employed. Accordingly, the flowback data indicates the absorbency/penetration time, flowback amount and amount of liquid retention of diaper samples incorporating the single layer nonwoven materials of Examples A-I and absorbent cores containing about 13.6 grams of woodpulp fluff and about 8.5 grams of superabsorbent material, such as Hoechst Celanese Co. IM 3900 or an equivalent thereof. These sample diapers had the flowback and liquid intake time values set forth in the following table:

TABLE B

Example	FIFE Liquid Intake Time (seconds)	FIFE Flowback (grams)
A	26.62	10.8
B	30.30	11.4
C	31.66	9.7
D	32.56	9.8
E	31.32	8.8
F	26.27	10.6
G	27.08	13.2
H	37.45	8.9
I	35.39	9.8

The Fluid Intake and Flowback Evaluation test results shown above for several specific Examples of the single layer nonwoven material of this embodiment are considered indicative of the open, porous fibrous structure of this embodiment of the present invention, which retains greater amounts of liquid, resulting in increased flowback values. As noted hereinabove, the absence of a prebonded liner layer results in the nonwoven material of this embodiment having a more open fiber fiber structure with improved liquid and air permeability properties.

Referring back to the embodiment of the present invention shown in FIG. 4, an important property of any bodyside liner material is its softness. In particular, it is important for the liner to be both extremely pliable as well as soft to the touch in consideration of the infant's comfort. The present inventor has observed that the body facing layer 12 of the nonwoven material 80 of the present invention exhibits excellent softness characteristics.

Another important property of a nonwoven liner and nonwoven fabrics in general is tensile strength, i.e., the resistance to tearing, and percent elongation prior to tearing. These properties have been measured by the present inventor on a device, such as the Instron Model TM 1000 (Instron Corp. having offices in Canton MA), that grips a sample (about 1 x

6 in. (25.4 x 1524 mm)) of a nonwoven fabric in a pair of jaws extending the entire width of the sample, and then pulls it apart at a constant rate of extension. The force needed to rupture the fabric is recorded as the tensile strength and the length of the fabric before rupture as compared to the original length provides the percent elongation value. These tests can be performed either with the fabric oriented in the jaws so that the force is applied in the machine direction, MD, or with the fabric oriented so that the force is applied in the cross direction, CD. It was observed that the nonwoven materials made in accordance with the present invention, several examples of which are discussed below, exhibited sufficient tensile strength and percent elongation properties.

Yet another property that is particularly important for a liner of an absorbent article, such as a disposable diaper, is the wettability of the liner. Depending upon the design of the absorbent article, it is usually desirable to have the liner be at least partially wettable in order to facilitate passage of liquid through to the absorbent core. In addition, it is even more desirable to provide a wettability gradient in the liner whereby liquid can be wicked away from the wearer for increased comfort and skin health. In particular, it is desireable to provide, as in the present invention, a body facing layer 12 that is less wettable than the "surge" layer 22, i.e., the layer closest to the absorbent material. In this way, liquid flows more easily through to the absorbent core material than it flows back to the wearer.

Many of the polymers that are suitable to make nonwoven webs are hydrophobic. Specifically, polyolefin fibers are completely hydrophobic. As a result, it is desirable for nonwoven webs made with these polymers to impart a desired level of wettability and hydrophilicity. It is known in the art that wettability of hydrophobic fibers, such as polypropylene, can be increased by the application of water-soluble finishes, typically ranging from about 0.3% to about 0.6%, to the surfaces of such hydrophobic fibers for improving the liquid management properties of such fibers in their end-

use applications. In the embodiment described herein, the polypropylene fibers employed can be made wettable by treating the fibers with water-soluble finishes before being formed into nonwoven layers 12 and 22.

Another contributing factor in producing the described wettability gradient is the blending of polyester fibers in a desired amount with the polypropylene fibers forming the second nonwoven layer 22. As described above, the differing pore sizes resulting from using the coarser, more resilient polyester fibers in a homogeneous blend of polypropylene and polyester fibers in nonwoven layer 22, produce the required wettability gradient between first layer 12 and second layer 22.

The following examples are provided to give a more detailed understanding of the invention. The particular compositions, proportions, materials and parameters are exemplary and are not intended to specifically limit the scope of the present invention.

EXAMPLES

EXAMPLE 1

A first layer was formed of 100% polypropylene (PP-196 manufactured by Hercules, Inc. having offices in Wilmington, DE) by blending on a conventional carding machine as described above. The first layer had a basis weight of about 18 g/m^2 (0.5 oz/yd^2). A second layer was formed of 60% polyester (SD-10 manufactured by Sam Yang having offices in Seoul, South Korea) and 40% PP-196 polypropylene by blending on a conventional carding machine. The second layer had a basis weight of about 32 g/m^2 (0.9 oz/yd^2). The first and second layers were thermobonded together by heated bonding rolls as shown in FIGS. 3 and 3a., with the bonding roll contacting the first layer maintained at a temperature of about 272°F (133°C) and the bonding roll contacting the second layer maintained at a temperature of about 315°F. (157°C) The line speed for the bonding rolls was about 80 ft/min. (24 m/min.) and the nip

pressure between the bonding rolls was about 300 pli. The thermobonding process yielded a nonwoven laminated material having a spaced apart bonding pattern with apertures formed within the bonding regions and a percent bond area of about 2%.

EXAMPLE 2

A first layer was formed of 100% PP-196 polypropylene by blending on a conventional carding machine as described above. The first layer had a basis weight of about 18 g/m^2 (0.5 oz/yd^2). A second layer was formed of 60% polyester (PET-295 manufactured by Hoechst Celanese having offices in Greenville, SC) and 40% PP-196 polypropylene by blending on a conventional carding machine. The second layer had a basis weight of about 32 g/m^2 (0.9 oz/yd^2). The first and second layers were thermobonded together by heated bonding rolls as shown in FIGS. 3 and 3a., with the bonding roll contacting the first layer maintained at a temperature of about 272°F (133°C) and the bonding roll contacting the second layer maintained at a temperature of about 315°F. (157°C) The line speed for the bonding rolls was about 80 ft/min. (24 m/min.) and the nip pressure between the bonding rolls was about 300 pli. The thermobonding process yielded a nonwoven laminated material having a spaced apart bonding pattern with apertures formed within the bonding regions and a percent bond area of about 2%.

EXAMPLE 3

A first layer was formed of 100% polypropylene fibers (PT110-20 supplied by Lohmann GmbH & Co. KG having offices in Neuwied, Germany). The first layer had a basis weight of about 20 g/m^2 (0.5 oz/yd^2). A second layer was formed of 60% polyester (PET-292 manufactured by Hoechst/AG having offices in Frankfurt, Germany) and 40% polypropylene (PP-71 "SOFT-71" manufactured by Danaklon A/S, Inc. having offices in Varde, Denmark) by blending on a conventional carding machine as described above. The second layer had a basis weight of about 32 g/m^2 (0.9 oz/yd^2). The first and second layer were

thermobonded together by heated bonding rolls as shown in FIGS. 3 and 3a., with the bonding roll contacting the first layer maintained at a temperature of about 272°F (133°C) and the bonding roll contacting the second layer maintained at a temperature of about 315°F. (157°C) The line speed for the bonding rolls was about 80 ft/min. (24 m/min.) and the nip pressure between the bonding rolls was about 300 pli. The thermobonding process yielded a nonwoven laminated material having a spaced apart bonding pattern with apertures formed within the bonding regions and a percent bond area of about 2%.

EXAMPLE 4

A first layer was formed of 100% PP-71 polypropylene using a conventional spunbonding forming process. The first layer had a basis weight of about 22 g/m^2 (0.6 oz/yd^2). A second layer was formed of 60% polyester PET-292 and 40% PP-71 polypropylene by blending on a conventional carding machine. The second layer had a basis weight of about 32 g/m^2 (0.9 oz/yd^2). The first and second layer were thermobonded together by heated bonding rolls as shown in FIGS. 3 and 3a., with the bonding roll contacting the first layer maintained at a temperature of about 272°F (133°C) and the bonding roll contacting the second layer maintained at a temperature of about 315°F. (157°C) The line speed for the bonding rolls was about 80 ft/min. (24 m/min.) and the nip pressure between the bonding rolls was about 300 pli. The thermobonding process yielded a nonwoven laminated material having a spaced apart bonding pattern with apertures formed within the bonding regions and a percent bond area of about 2%.

EXAMPLE 5

A first layer was formed of 100% polypropylene (75% PP-196 and 25% PP-190, both manufactured by Hercules, Inc. having offices in Wilmington, DE) by blending on a conventional carding machine as described above. The first layer had a basis weight of about 18 g/m^2 (0.5 oz/yd^2). A second layer was formed of 60% PET-292 polyester and 40% PP-71

polypropylene by blending on a conventional carding machine. The second layer had a basis weight of about 32 g/m^2 (0.9 oz/yd^2). The first and second layer were thermobonded together by heated bonding rolls as shown in FIGS. 3 and 3a., with the bonding roll contacting the first layer maintained at a temperature of about 272°F (133°C) and the bonding roll contacting the second layer maintained at a temperature of about 315°F. (157°C) The line speed for the bonding rolls was about 80 ft/min. (24 m/min.) and the nip pressure between the bonding rolls was about 300 pli. The thermobonding process yielded a nonwoven laminated material having a spaced apart bonding pattern with apertures formed within the bonding regions and a percent bond area of about 2%.

EXAMPLE 6

A first layer was formed of 100% PP-196 polypropylene by blending on a conventional carding machine as described above. The first layer had a basis weight of about 18 g/m^2 (0.5 oz/yd^2). A second layer was formed of 60% PET-295 polyester and 40% PP-196 polypropylene by blending on a conventional carding machine. The second layer had a basis weight of about 32 g/m^2 (0.9 oz/yd^2). The first and second layers were thermobonded together by heated bonding rolls as shown in FIGS. 3 and 3a., with the bonding roll contacting the first layer maintained at a temperature of about 272°F (133°C) and the bonding roll contacting the second layer maintained at a temperature of about 315°F. (157°C) The line speed for the bonding rolls was about 80 ft/min. (24 m/min.) and the nip pressure between the bonding rolls was about 300 pli. The thermobonding process yielded a nonwoven laminated material having a spaced apart bonding pattern with apertures formed within the bonding regions and a percent bond area of about 2%.

The resultant nonwoven laminated materials of the above examples had the properties set forth in the following table:

TABLE I

Example	Basis Weight (g/m^2)	Thick-ness (in.)	Density (g/cc)	Tensile (g/in.) MD	Tensile (g/in.) CD	% Elongation MD
1	49.0	0.046	0.041	1578.0	196.0	33.2
2	52.0	0.046	0.044	1585.0	198.0	32.0
3	51.0	0.048	0.042	2672.0	402.0	29.2
4	56.5	0.051	0.043	1439.0	382.0	26.1
5	51.2	0.057	0.034	1509.0	228.0	39.6
6	51.5	0.058	0.035	1610.0	263.0	37.3

For the purposes of the present disclosure, the following test procedures can be used to determine particular parameters of the nonwoven material 10 of the present invention.

The Fluid Intake and Flowback Evaluation (FIFE) test has been designed to measure the absorbency/penetration time, flowback amount and amount of liquid retention in the liner of a disposable absorbent article. The absorbency/penetration time (in seconds) is measured by using a stopwatch and visually determining the length of time required to absorb simulated urine voidings. The flowback test measures, in grams, the amount of liquid that emerges from the "user side" of the absorbent article after it has absorbed each of three liquid insults and pressure has been applied.

The apparatus shown in FIGS. 7 and 8 is used for this test. A sample diaper to be tested, as shown in FIG. 4 and shown in phantom at 102 in FIG. 7, is weighed to the nearest 0.1 g. The sample 102 is prepared by cutting the leg and waist elastic members and containment flap elastics (not shown) along their length in order to allow the sample to lie flat. Sample dimensions, weight and density profiles of the sample 102 and composition of the absorbent core must be appropriately controlled to obtain valid results. Data reported herein were obtained from 12 in. x 12 in. (305 mm. x 305 mm.) rectangular samples including the nonwoven materials 10 described above in Examples 4, 5 and 6 and absorbent cores containing about 10 grams of woodpulp fluff and about 12 grams of superabsorbent material, such as DOW

DRYTECH 835 or an equivalent thereof.

The sample 102 is placed flat and smooth under an 880 g. cylinder plate assembly 104 such that the cylinder 106, which has a 5.1 cm i.d., ends up in a designated location 108. For example, the designated location 108 can range from about 4 1/2 inches (114.3 mm.) to about 5 3/4 inches (146.1 mm.) from the edge of the sample 102, depending upon the size (e.g., small (s), medium (m), large(l) or extra large(xl)) of the absorbent article to be tested. Under the sample 102 is a raised platform 110 that is 1/2 inch (12.7 mm.) high (d) x 6 inches (152.4 mm.) long (e) x 3 inches (76.2 mm.) wide (f). Also, the cylinder 106 extends a distance (g) of about 1/32 inch (0.8 mm.) below the cylinder plate assembly 104.

Funnel 112 on top of cylinder 106 is perpendicular to the sample 102 and centered on the designated location 108. A specified amount of synthetic urine (e.g., 50 ml, 80 ml or 100 ml for small, medium and large or extra large diapers, respectively), is poured through the funnel 112. (An example of a suitable synthetic urine is Item No. K-C 399105, available from PPG Industries having offices in Appleton, WI.) The time elapsing between the first liquid contact with the sample 102 and the time when liquid no longer is visible on the surface of the sample 102 is measured with a stop watch. One minute after the initial liquid insult is imbibed, a second insult of the same size is introduced. The time to imbibe the second insult of liquid is measured as for the first insult.

Referring now to FIGS. 9 and 10, one minute after the second insult is imbibed, the sample 102 is placed on a vacuum apparatus 114 and covered with blotter paper 116 together with liquid impervious latex sheeting 118. A 35,000 dyne/cm^2 (about 0.5 psi) vacuum pressure then is applied to suck the impervious latex sheeting 118 onto the blotter 116 and sample 102 for two minutes. After the pressure is released, the wet blotter paper 116 then is weighed. The increase in weight (in grams) of the blotter paper 116 represents the flowback.

Within one minute after the pressure is released from the

sample 102, a third liquid insult is introduced and timed as described above. The liquid intake time then is the number of seconds for the prescribed amount of liquid (80 ml for the results described herein) to enter the sample 102.

Samples 102 including the nonwoven laminated materials of the above Examples 4, 5 and 6 had the flowback and liquid intake time values set forth in the following table:

TABLE II

Example	FIFE Liquid Intake Time (seconds)	FIFE Flowback (grams)
4	33	7.1
5	34	1.9
6	30	3.2

While the Fluid Intake and Flowback Evaluation test results are indicated above for several specific Examples, absorbent articles incorporating the nonwoven material 10 described herein can have liquid intake times ranging from about 11 seconds to about 38 seconds and flowback values ranging from about 1.0 gram to about 9.0 grams.

It is contemplated that the nonwoven material 10 constructed in accordance with the present invention will be tailored and adjusted by those of ordinary skill in the art to accommodate various levels of performance demand imparted during actual use. For example, mild urinary incontinence and menstrual flow pads involve different delivery rates, volumes and timing than infant urine insults. Moreover, the liquid in the surge can vary in terms of the liquid viscosity, surface tension, temperature and other physical properties that could affect the performance of the nonwoven material 10 in the various actual product end usages. Accordingly, while this invention has been described by reference to the above embodiments and examples, it will be understood that this invention is capable of further modifications. This application is, therefore, intended to cover any variations, uses or adaptations of the invention following the general principles thereof, and

including such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and fall within the limits of the appended claims.

CLAIMS

1. A laminated fibrous material comprising:

a first fibrous layer comprising a plurality of fibers of one or more thermoplastic polymeric materials;

a second fibrous layer comprising a plurality of fibers of two or more thermoplastic polymeric materials;

said first and second layers being bonded together in a spaced apart bonding pattern comprising a plurality of discrete compacted bonding areas with lightly bonded fiber spans therebetween; and

said bonding areas having apertures formed therein.

2. The laminated fibrous material of claim 1 wherein said first and second layers comprise nonwoven webs.

3. The laminated fibrous material of claim 2 wherein at least one of said first and second layers comprises a spunbonded web.

4. The laminated fibrous material of claim 2 wherein said first layer has fibers thereof bonded to one another.

5. The laminated fibrous material of claim 2 wherein said first and second layers are thermally bonded together.

6. The laminated fibrous material of claim 2 wherein the bonded areas constitute from about 1.0 to about 6.0 percent of the surface area of the material.

7. The laminated fibrous material of claim 2 wherein the bonded areas constitute from about 2.0 to about 4.0 percent of the surface area of the material.

8. The laminated fibrous material of claim 2 wherein said first layer comprises one or more thermoplastic polymeric materials selected from the group consisting of polyolefins and said second layer comprises a blend of two or more thermoplastic polymeric materials selected from the group of polyolefins and polyesters.

9. The laminated fibrous material of claim 8 wherein said first layer comprises polypropylene and said second layer comprises a blend of polypropylene and polyester.

10. The laminated fibrous material of claim 9 wherein said first layer comprises about 100 percent polypropylene and said

second layer comprises from about 70 percent polypropylene and about 30 percent polyester to about 25 percent polypropylene and about 75 percent polyester.

11. The laminated fibrous material of claim 9 wherein said first layer comprises about 100 percent polypropylene and said second layer comprises about 40 percent polypropylene and about 60 percent polyester.

12. The laminated fibrous material of claim 2 wherein said first layer has a higher density than said second layer, as determined prior to said bonding of said first and second layers.

13. An absorbent article comprising:

a liquid-permeable bodyside liner;

a liquid-impermeable outer cover;

an absorbent core disposed between said bodyside liner and said outer cover; and

a laminated fibrous material disposed adjacent at least a portion of said bodyside liner;

said laminated fibrous material comprising a first fibrous layer comprising a plurality of fibers of one or more thermoplastic polymeric materials;

a second fibrous layer comprising a plurality of fibers of two or more thermoplastic polymeric materials;

said first and second layers being bonded together in a spaced apart bonding pattern comprising a plurality of discrete compacted bonding areas with lightly bonded fiber spans therebetween; and

said bonding areas having apertures formed therein.

14. An absorbent article comprising:

a liquid-permeable bodyside liner;

a liquid-impermeable outer cover;

a laminated fibrous material disposed adjacent at least a portion of said bodyside liner;

said laminated fibrous material comprising a first fibrous layer comprising a plurality of fibers of one or more thermoplastic polymeric materials;

a second fibrous layer comprising a plurality of fibers of

two or more thermoplastic polymeric materials;

said first and second layers being bonded together in a spaced apart bonding pattern comprising a plurality of discrete compacted bonding areas with lightly bonded fiber spans therebetween;

said bonding areas having apertures formed therein; and

an absorbent core disposed between said laminated fibrous material and said outer cover.

15. The absorbent article of claims 13 or 14 wherein said first layer comprises about 100 percent polypropylene and said second layer comprises from about 70 percent polypropylene and about 30 percent polyester to about 25 percent polypropylene and about 75 percent polyester.

16. The absorbent article of claims 13 or 14 wherein said first layer comprises a bonded carded web which has a basis weight range of about 16 g/m^2 to about 28 g/m^2 and is composed of polypropylene fibers having a fiber denier range of about 1.0 to about 3.0 and said second layer comprises a bonded carded web which has a basis weight range of about 24 g/m^2 to about 35 g/m^2 and is composed of a blend of polypropylene fibers having a fiber denier range of about 1.0 to about 3.0 and polyester fibers having a fiber denier range of about 3.0 to about 9.0.

17. The absorbent article of claim 14 wherein said nonwoven laminate material has a length dimension that is less than the length of said outer cover and a width dimension that is less than the width of said outer cover.

18. The absorbent article of claim 14 wherein said nonwoven laminate material has a length dimension that is less than the length of said absorbent core.

19. A process for making a laminated fibrous material comprising the steps of:

a. forming a first fibrous layer comprising a plurality of fibers of one or more thermoplastic polymeric materials;

b. forming a second fibrous layer comprising a plurality of fibers of two or more thermoplastic polymeric materials;

c. bonding said first and second layers together in a spaced apart bonding pattern comprising a plurality of discrete compacted bonding areas with lightly bonded fiber spans therebetween; and

d. forming apertures within said bonding areas.

20. A process according to claim 19 wherein said forming step b. comprises the step of depositing fibers of said second layer onto said first layer after said first layer has been formed.

21. A process according to claim 19 wherein said forming step a. comprises bonding said fibers of said first layer to one another.

22. A process according to claim 19 wherein said bonding step c. comprises thermal bonding.

23. A process according to claim 22 wherein said bonding step c. comprises thermal bonding by a first bonding roll having a spaced apart raised bonding pattern on the outer surface thereof and a second bonding roll having a plurality of raised bonding points on the outer surface thereof.

24. A process according to claim 19 wherein said first and second layers comprise nonwoven webs.

25. A process according to claim 19 wherein at least one of said first and second layers comprise spunbonded webs.

26. A process according to claim 19 wherein said first layer comprises one or more thermoplastic polymeric materials selected from the group consisting of polyolefins and said second layer comprises a blend of two or more thermoplastic polymeric materials selected from the group of polyolefins and polyesters.

27. An apparatus for forming a laminated fibrous material comprising:

means for forming a first fibrous layer comprising a plurality of fibers of one or more thermoplastic polymeric materials;

means for forming a second fibrous layer comprising a plurality of fibers of two or more thermoplastic polymeric materials;

bonding means for bonding said first and second layers together in a spaced apart bonding pattern comprising a plurality of discrete compacted bonding areas with lightly bonded fiber spans therebetween; and

means for forming apertures within said bonding areas.

28. An apparatus for forming a laminated fibrous material according to claim 27 wherein said bonding means comprises a first bonding roll having a spaced apart raised bonding pattern on the outer surface thereof and a second bonding roll having a plurality of raised bonding points on the outer surface thereof.

29. An apparatus for forming a laminated fibrous material according to claim 27 further comprising first bonding means for bonding fibers of said first fibrous layer to one another.

30. An apparatus for forming a laminated fibrous material according to claim 28 further comprising:

means for heating at least one of said first and second bonding rolls;

means for rotating said first bonding roll; and

means for rotating said second bonding roll.

31. An apparatus for forming a laminated fibrous material according to claim 30 wherein said first bonding roll has a first rotational speed and said second bonding roll has a second rotational speed, said first speed being at least 4 percent greater than said second speed.

32. A fibrous material comprising:

a fibrous layer comprising a plurality of fibers of one or more thermoplastic polymeric materials;

said fibrous layer having an upper surface with an upper surface area and a lower surface with a lower surface area;

said fibers of said fibrous layer being bonded together in a spaced apart bonding pattern comprising a plurality of discrete compacted bonding regions with lightly bonded fibers spans therebetween; and

said bonding regions having apertures formed therein.

33. The fibrous material of claim 32 wherein said fibrous layer comprises a nonwoven web.

34. The fibrous material of claim 33 wherein said fibrous layer comprises a spunbonded web.

35. The fibrous material of claim 33 wherein said fibers of said fibrous layer are thermally bonded together.

36. The fibrous material of claim 33 wherein said bonding regions constitute from about 4.0 percent to about 35.0 percent of the surface area of either said upper surface or said lower surface of said fibrous layer.

37. The fibrous material of claim 36 wherein said bonding regions constitute from about 6.0 percent to about 15.0 percent of the surface area of either said upper surface or said lower surface of said fibrous layer.

38. The fibrous material of claim 32 wherein said fibrous layer comprises one or more thermoplastic polymeric materials selected from the group consisting of polyolefins and polyesters.

39. The fibrous material of claim 32 wherein said fibrous layer comprises two or more thermoplastic polymeric materials selected from the group consisting of polyolefins and polyesters.

40. The fibrous material of claim 38 wherein said fibrous layer comprises a blend of polypropylene fibers and polyester fibers.

41. The fibrous material of claim 38 wherein said fibrous layer further comprises bicomponent fibers.

42. The fibrous material of claim 39 wherein said fibrous layer further comprises bicomponent fibers.

43. The fibrous material of claim 38 wherein said fibrous layer comprises a blend of polyester sheath-core bicomponent fibers and polyester single component fibers.

44. The fibrous material of claim 40 wherein said fibrous layer comprises from about 70 percent polypropylene fibers and about 30 percent polyester fibers by total weight of said fibrous material to about 25 percent polypropylene fibers and about 75 percent polyester fibers by total weight of said fibrous material.

45. The fibrous material of claim 44 wherein said fibrous layer comprises about 50 percent polypropylene fibers and about 50 percent polyester fibers by total weight of said fibrous material.

46. The fibrous material of claim 39 wherein said fibrous layer further comprises from about 10 percent to about 20 percent cellulose or natural fibers.

47. An absorbent article comprising:

a liquid-permeable bodyside liner;

a liquid-impermeable outer cover;

an absorbent core disposed between said bodyside liner and said outer cover; and

a fibrous material disposed adjacent at least a portion of said bodyside liner;

said fibrous material comprising a fibrous layer comprising a plurality of fibers of one or more thermoplastic polymeric materials;

said fibers of said fibrous layer being bonded together in a spaced apart bonding pattern comprising a plurality of discrete compacted bonding regions with lightly bonded fibers spans therebetween; and

said bonding regions having apertures formed therein.

48. An absorbent article comprising:

a liquid-permeable bodyside liner;

a liquid-impermeable outer cover;

a fibrous material disposed adjacent at least a portion of said bodyside liner;

said fibrous material comprising a fibrous layer comprising a plurality of fibers of one or more thermoplastic polymeric materials;

said fibers of said fibrous layer being bonded together in a spaced apart bonding pattern comprising a plurality of discrete compacted bonding regions with lightly bonded fibers spans therebetween;

said bonding regions having apertures formed therein; and

an absorbent core disposed between said fibrous material and said outer cover.

49. The absorbent article of claims 47 or 48 wherein said fibrous layer comprises from about 70 percent polypropylene fibers and about 30 percent polyester fibers by total weight of said fibrous layer to about 25 percent polypropylene fibers and about 75 percent polyester fibers by total weight of said fibrous layer.

50. The absorbent article of claim 49 wherein said fibrous layer further comprises bicomponent fibers.

51. The absorbent article of claims 47 or 48 wherein said fibrous layer comprises a bonded carded web which has a basis weight range of about 20.0 g/m^2 to about 100.0 g/m^2 and comprises a blend of polypropylene fibers having a fiber denier range of about 1.0 to about 10.0 and polyester fibers having a fiber denier range of about 1.0 to about 9.0.

52. The absorbent article of claim 51 wherein said fibrous layer further comprises bicomponent fibers.

53. The absorbent article of claims 47 or 48 wherein said fibrous layer has a length dimension that is less than the length of said outer cover and a width dimension that is less than the width of said outer cover.

54. The absorbent article of claims 47 or 48 wherein said fibrous layer has a length dimension that is less than the length of said absorbent core.

55. A fibrous material comprising:

a fibrous layer comprising a plurality of fibers of one or more thermoplastic polymeric materials;

said fibrous layer having an upper surface with an upper surface area and a lower surface with a lower surface area;

said fibrous layer having a basis weight of from about 20.0 g/m^2 to about 100.0 g/m^2 and a density of from about 0.030 g/cc to about 0.080 g/cc;

said fibers of said fibrous layer being bonded together in a spaced apart bonding pattern comprising a plurality of discrete compacted bonding regions;

said bonding regions constituting from about 4.0 percent to

about 35.0 percent of the surface area of either said upper surface or said lower surface of said fibrous layer; and

said bonding regions having apertures formed therein.

56. A process for making a fibrous material comprising the steps of:

a. forming a fibrous layer comprising a plurality of fibers of one or more thermoplastic polymeric materials, said fibrous layer having an upper surface with an upper surface area and a lower surface with a lower surface area;

b. bonding said fibers of said fibrous layer together in a spaced apart bonding pattern comprising a plurality of discrete compacted bonding regions with lightly bonded fiber spans therebetween; and

c. forming apertures within said bonding regions.

57. A process for making a fibrous material according to claim 56 wherein said bonding step b. further comprises forming bonding regions constituting from about 4.0 percent to about 35 percent of the surface area of either said upper surface or said lower surface of said fibrous layer.

58. A process for making a fibrous material according to claim 56 wherein said bonding step b. comprises thermally bonding said fibers of fibrous layer by first and second bonding rolls opposedly positioned relative to each other, each of said bonding rolls having an outer surface, said first and second bonding rolls having different raised bonding patterns on said outer surfaces thereof; and

passing said fibrous layer between said bonding rolls such that said upper and lower surfaces of said fibrous layer each

are in contact with an outer surface of one of said bonding rolls in order to form said spaced apart bonding pattern.

59. A process for making a fibrous material according to claim 56 wherein said fibrous layer comprises a nonwoven web.

60. A process for making a fibrous material according to claim 56 wherein said fibrous layer comprises one or more thermoplastic polymeric materials selected from the group consisting of polyolefins and polyesters.

61. A process according to claim 56 wherein said fibrous layer comprises two or more thermoplastic polymeric materials selected from the group consisting of polyolefins and polyesters.

62. A process for making a fibrous material according to claim 61 wherein said fibrous layer further comprises bicomponent fibers.

63. An apparatus for forming a fibrous material comprising:

means for forming a fibrous layer comprising a plurality of fibers of one or more thermoplastic polymeric materials;

bonding means for bonding said fibers of said fibrous layer together in a spaced apart bonding pattern comprising a plurality of discrete compacted bonding regions with lightly bonded fiber spans therebetween; and

means for forming apertures within said bonding regions.

64. An apparatus for forming a fibrous material according to claim 63 further comprising:

first and second bonding rolls opposedly positioned relative to each other;

each of said bonding rolls having an outer surface in

contact with an outer surface of said fibrous layer as said fibrous layer passes therebetween;

said first and second bonding rolls having different raised bonding patterns on said outer surfaces thereof; and

said first bonding roll having a spaced apart raised bonding pattern on the outer surface thereof and said second bonding roll having a plurality of raised bonding point on the outer surface thereof.

65. An apparatus for forming a fibrous material according to claim 63 further comprising:

means for heating at least one of said first and second bonding rolls;

means for rotating said first bonding roll; and

means for rotating said second bonding roll.

66. An apparatus for forming a fibrous material according to claim 65 wherein said first bonding roll has a first rotational speed and said second bonding roll has a second rotational speed, said first and second rotational speeds differing from about 4 percent to about 50 percent.

67. An apparatus for forming a fibrous material according to claim 63 wherein the formation of said apertures is substantially limited to said bonding regions.

68. An apparatus for forming a fibrous material according to claim 63 wherein said bonding means bonds said fibers of said fibrous layer together in a spaced apart bonding pattern such that the resulting fibrous material has a percent bond area of from about 4 percent to about 35 percent.

69. An apparatus for forming a fibrous material according

to claim 68 wherein said bonding means bonds said fibers of said fibrous layer together in a spaced apart bonding pattern such that the resulting fibrous material has a percent bond area of from about 6 percent to about 15 percent.

70. An apparatus for forming a fibrous material according to claim 64 wherein said spaced apart bonding pattern is formed by points of contact between said raised bonding patterns on said outer surfaces of said first and second bonding rolls.

71. An apparatus for forming a fibrous material according to claim 70 wherein said apertures are formed by points of contact between said raised bonding patterns on said outer surfaces of said first and second bonding rolls.

72. An apparatus for forming a fibrous material according to claim 64 wherein said first bonding roll has a percent bond area of from about 9 percent to about 70 percent and said second roll has a percent bond area of from about 10 percent to about 50 percent.

73. An apparatus for forming a fibrous material according to claim 72 wherein said first bonding roll has a percent bond area of from about 33 percent to about 45 percent and said second roll has a percent bond area of from about 18 percent to about 24 percent.

74. An apparatus for forming a fibrous material according to claim 64 wherein said raised bonding patterns of said first and second bonding rolls are configured to optimize the number of said apertures formed within said bonding regions.

75. An apparatus for forming a fibrous material according

to claim 65 further comprising:

means for heating said first bonding roll to a first bonding temperature; and

means for heating said second bonding roll to a second bonding temperature.

76. An apparatus for forming a fibrous material according to claim 75 wherein said first bonding temperature ranges from about 260°F (127°C) to about 450°F (232°C) and said second bonding temperature ranges from about 270°F (132°C) to about 450°F (232°C).

77. An apparatus for forming a fibrous material according to claim 76 wherein said first bonding temperature ranges from about 275°F (135°C) to about 400°F (204°C) and said second bonding temperature ranges from about 275°F (135°C) to about 400°F (204°C).

78. An apparatus for forming a fibrous material according to claim 65 wherein said first and second bonding rolls are rotated such that said fibrous layer passing therebetween has a line speed ranging from about 17 meters per minute to about 200 meters per minute.

79. An apparatus for forming a fibrous material according to claim 78 wherein said first and second bonding rolls are rotated such that said fibrous layer passing therebetween has a line speed ranging from about 17 meters per minute to about 100 meters per minute.

80. An apparatus for forming a fibrous material according to claim 64 wherein said first and second bonding rolls produce a nip pressure of from about 60 pounds per linear inch

to about 400 pounds per linear inch.

81. An apparatus for forming a fibrous material comprising:

means for forming a fibrous layer comprising a plurality of fibers of one or more thermoplastic polymeric materials and having a basis weight of from about 20.0 g/m^2 to about 100.0 g/m^2 and a density of from about 0.040 g/cc to about 0.065 g/cc;

thermal bonding means for thermobonding said fibers of said fibrous layer together in a spaced apart bonding pattern comprising a plurality of discrete compacted bonding regions with lightly bonded fiber spans therebetween; and

means for forming apertures within said bonding regions.

82. An apparatus for forming a fibrous material according to claim 81 wherein said fibrous layer comprises thermoplastic polypropylene and polyester fibers, the ratio of polypropylene to polyester fibers by total weight of said fibrous layer ranging from about 70:30 to about 25:75.

83. An apparatus for forming a fibrous material according to claim 82 wherein said fibrous layer further comprises bicomponent fibers.

84. An apparatus for forming a fibrous material comprising:

means for forming a fibrous layer comprising a plurality of fibers of one or more thermoplastic polymeric materials;

a first thermal bonding roll and a second thermal bonding roll opposedly positioned relative to each other in order to form a spaced apart bonding pattern on said fibrous layer;

each of said bonding rolls having an outer surface for

contacting a surface of said fibrous layer as said fibrous layer passes therebetween;

said first and second bonding rolls having different raised bonding patterns on said outer surfaces thereof;

said first bonding roll having a spaced apart raised bonding pattern on the outer surface thereof and said second bonding roll having a plurality of raised bonding points on the outer surface thereof; and

said first and second bonding rolls being configured to form apertures within said bonding regions, said apertures being formed by the points of contact between said raised bonding patterns on said outer surfaces thereof.

85. An apparatus for forming a laminated fibrous material according to claim 84 wherein said first bonding roll has a first rotational speed and said second bonding roll has a second rotational speed, said first and second rotational speeds differing from about 4 percent to about 50 percent.

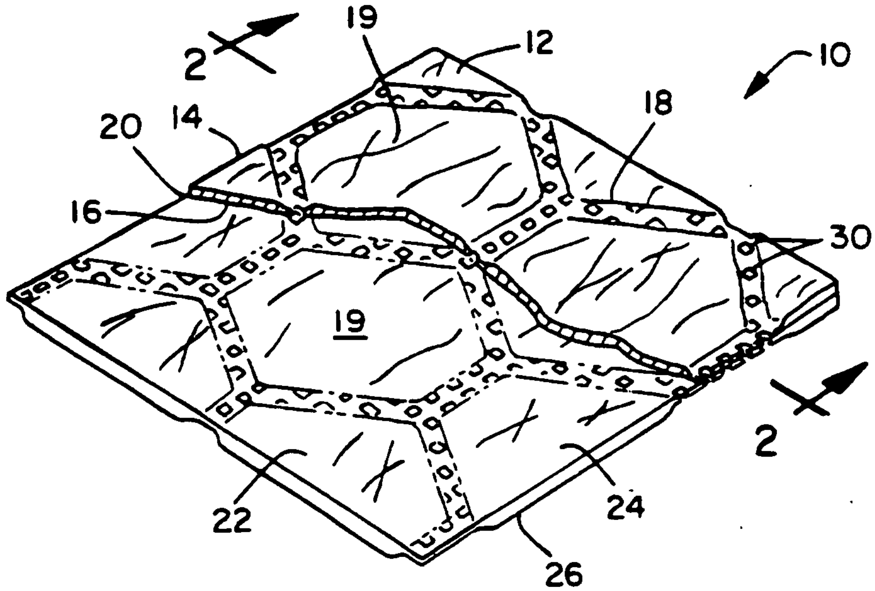

FIG. 1

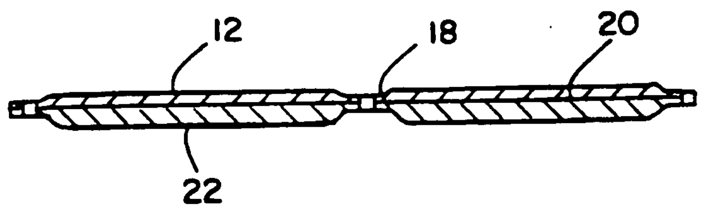

FIG. 2

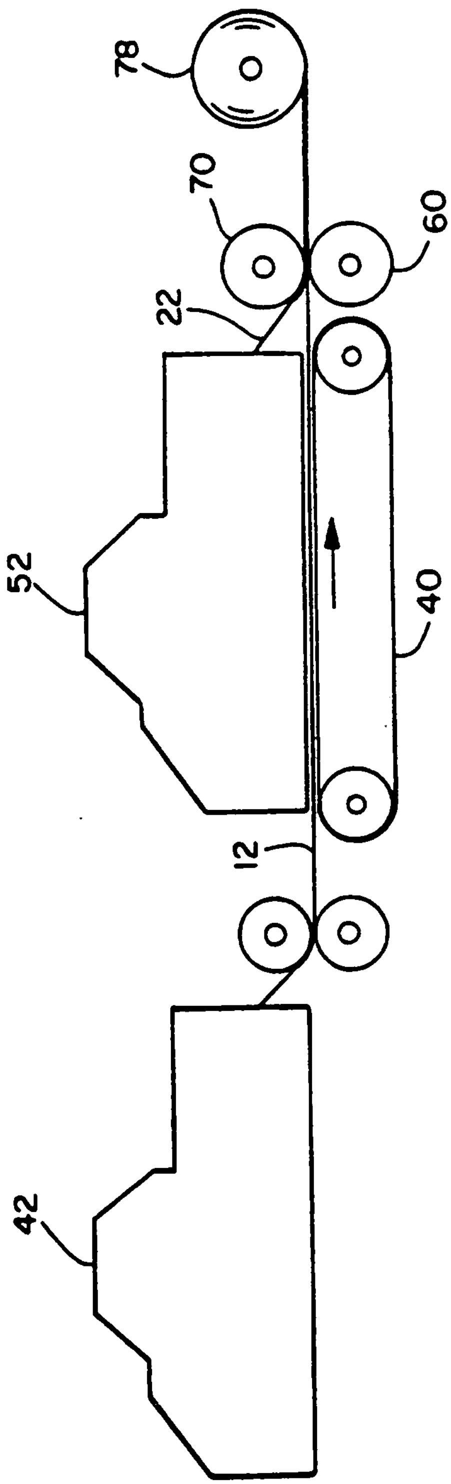

FIG. 3

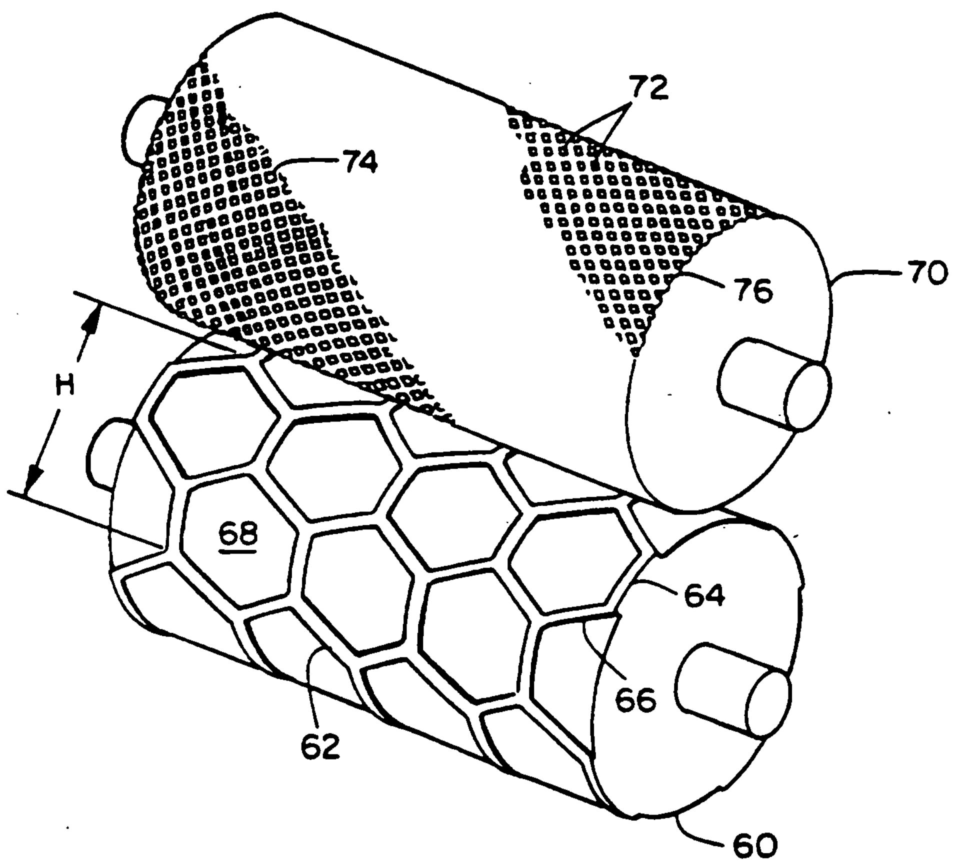

FIG. 3A

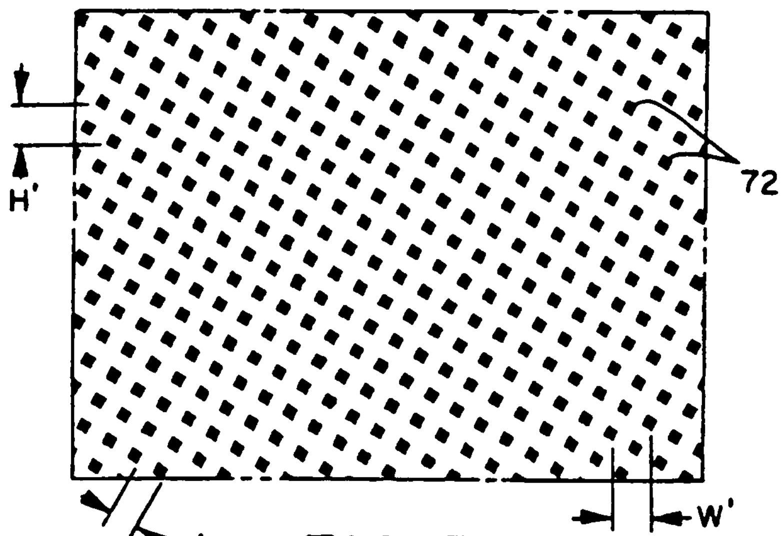

FIG. 3B

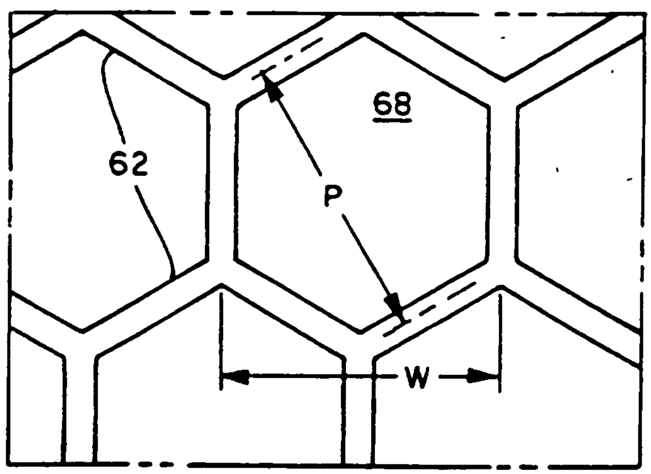

FIG. 3C

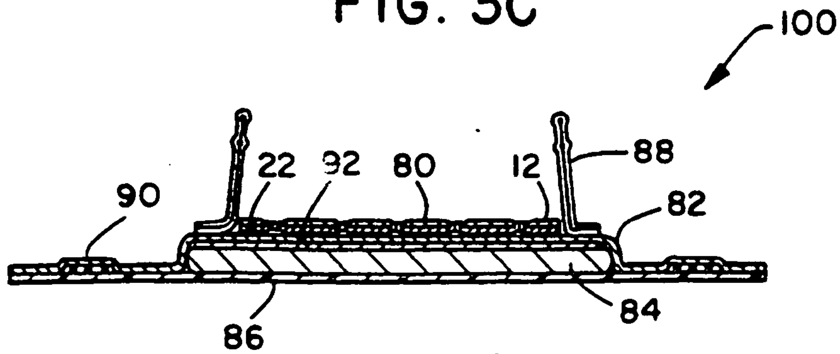

FIG. 4

FIG. 5

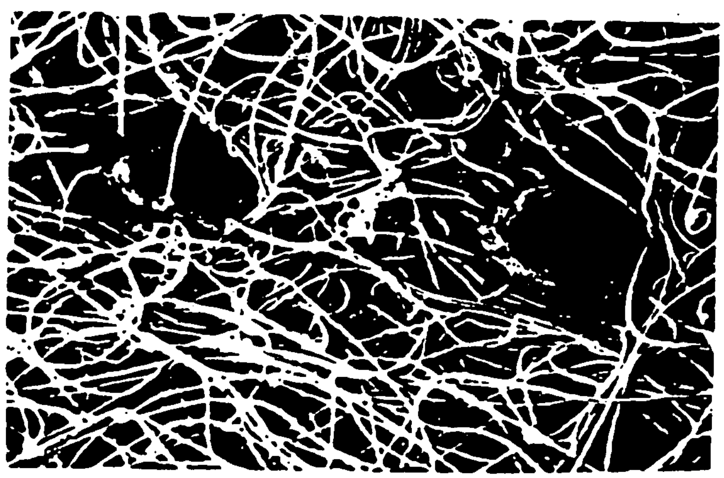

FIG. 6

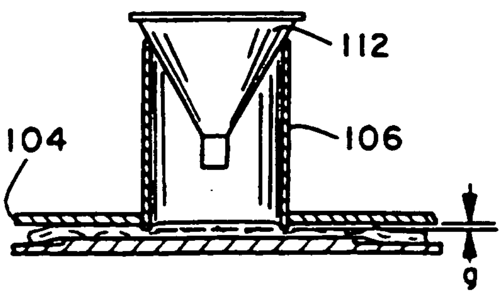

FIG. 8

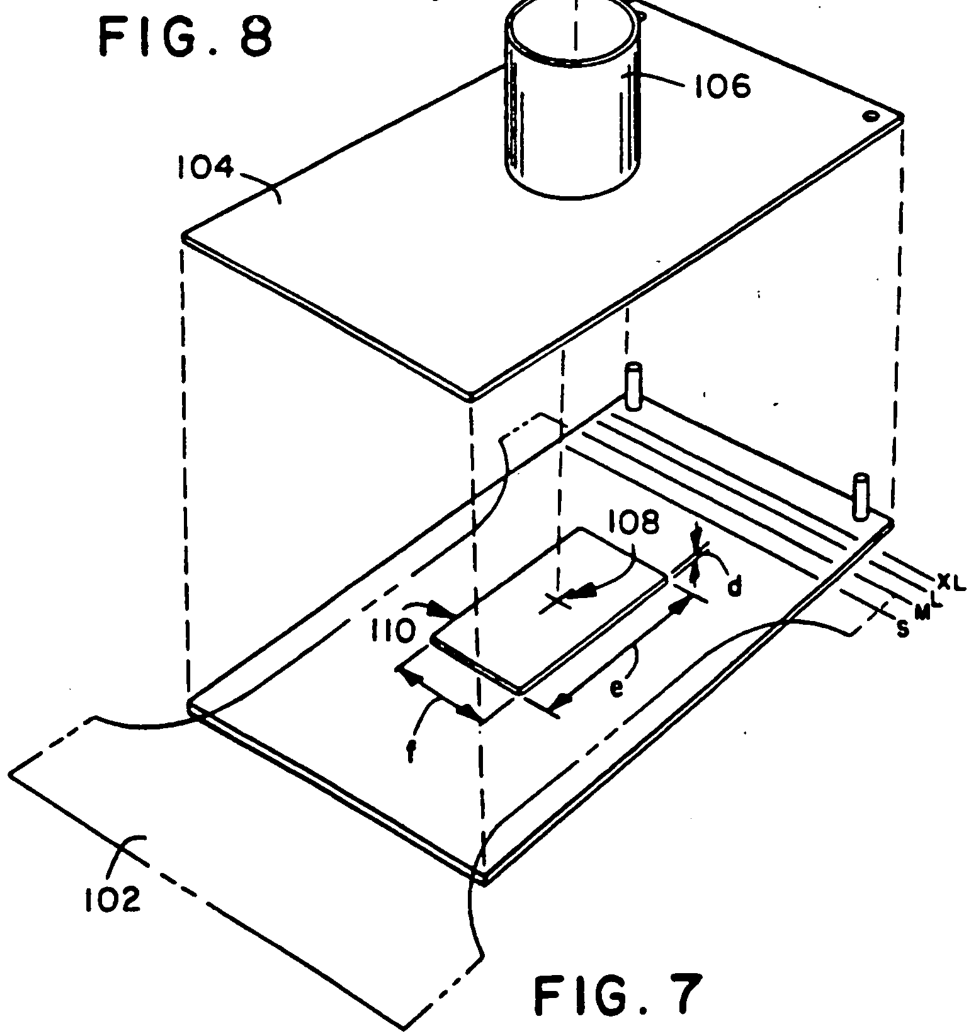

FIG. 7

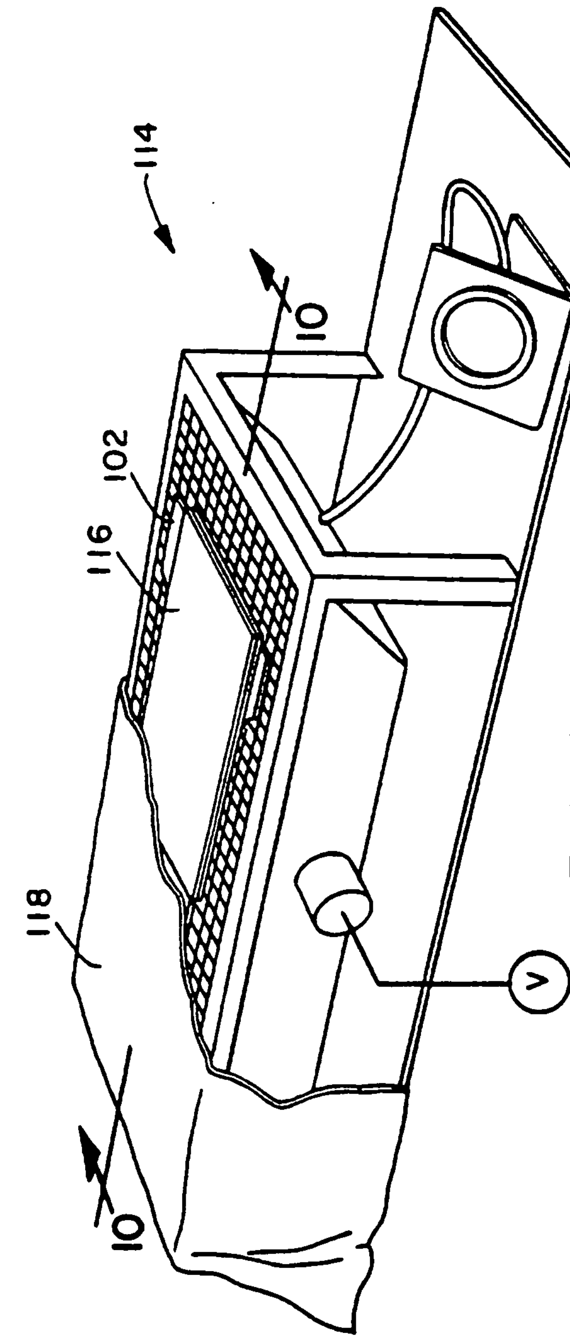

FIG. 9

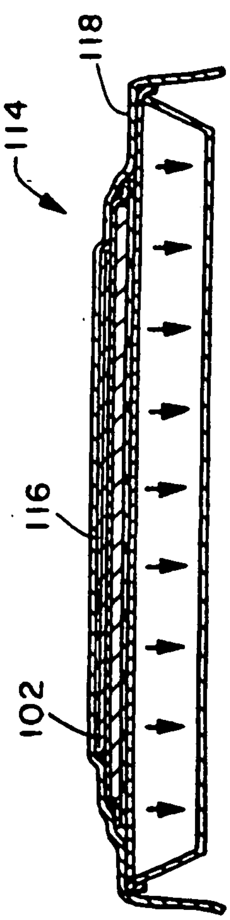

FIG. 10

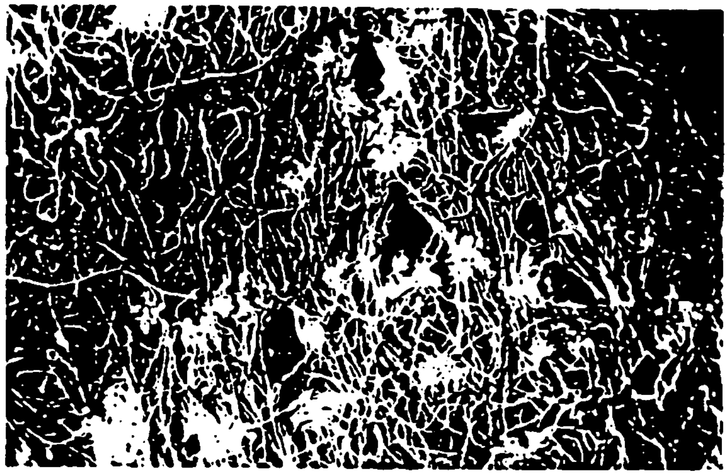

FIG. 5

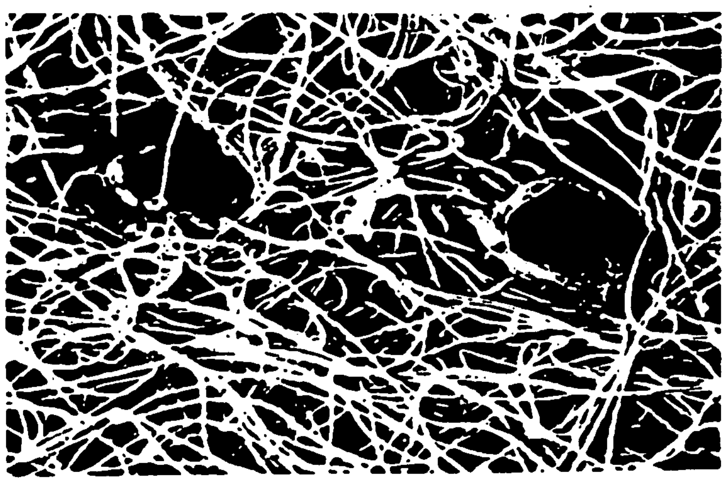

FIG. 6

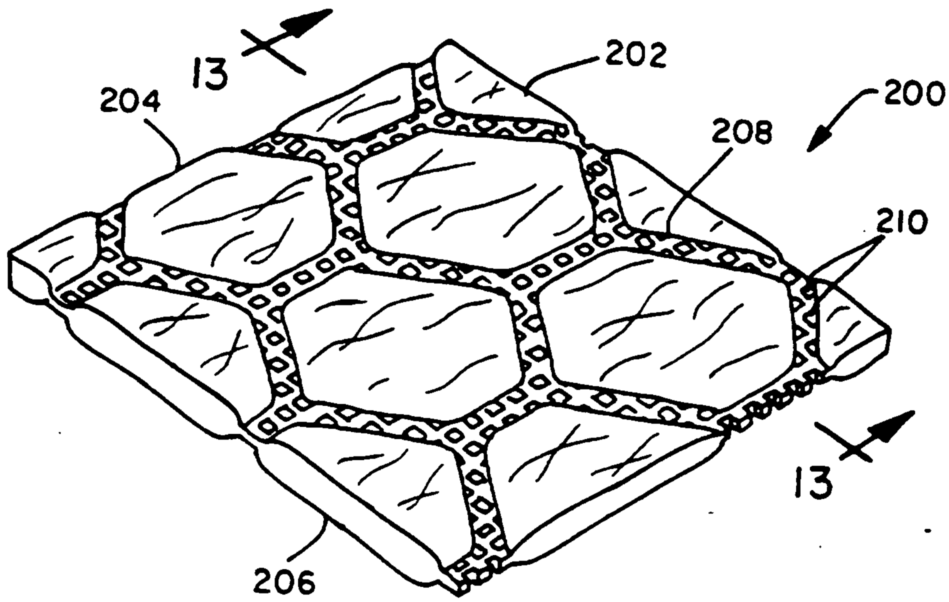

FIG. 12

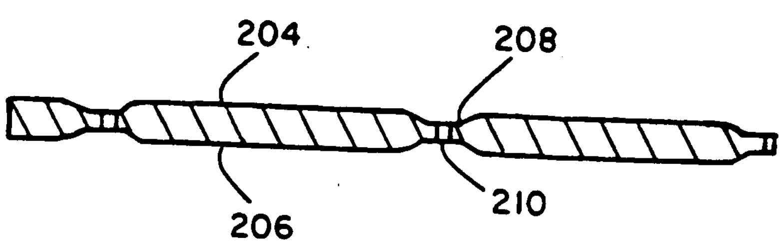

FIG. 13

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 95/11586

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B32B5/26 B32B7/04 D04H13/00 D04H1/54 A61F13/15

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B32B D04H A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP,A,0 596 191 (KIMBERLY CLARK CO) 11 May 1994 see claims	1-13,15, 19-31
A		32-85
X	EP,A,0 164 740 (CHICOPEE) 18 December 1985 see claims 1-3 see page 4, line 24 - page 5, line 20 see page 7, line 5 - line 21	32,33, 35, 38-40, 42,46, 55,56, 63,65-67

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 January 1996	12-02-1996

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	McConnell, C

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US,A,4 863 785 (BERMAN MARK H S ET AL) 5 September 1989 see column 2, line 66 - column 4, line 25; figures	1-12, 19-30
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